POWER PLANT ENGINEERING

Trade Mark, Reg. U. S. Pat. Office

VOL. XXVI CHICAGO, OCTOBER 15, 1922 No. 20

Plant of the Waterway Paper Products Co.

BOILER PLANT IS WELL EQUIPPED WITH COMBUSTION REGULATORS TO MAINTAIN THE NECESSARY CONSTANT STEAM PRESSURE

WHEN YOU THINK OF paper mills, you think of some isolated plant, miles away from civilization, up in the heart of the forests which furnish the original raw material, but such is not always the case. Recently there was constructed, right in the heart of Chicago, a paper mill for the manufacture of news print. This plant, operated by the Waterway Paper Products Co., is located at 32nd St. and Kedzie Ave. For raw material it uses, not timber from our fast diminishing forests, but waste paper accumulated in the city. The output of the plant amounts to about 37 T. of news print stock a day. This output is all consumed by the Chicago Daily News and amounts to perhaps 20 per cent of the amount required by that paper.

As large amounts of steam are required in the manufacture of paper, the mill is equipped with a power plant of its own, large enough to operate 400-hp. installed engine horsepower. In addition there are a number of electric motors used which are supplied with purchased power from the Commonwealth Edison Co.

BOILER ROOM

WHILE THE engines are housed in the plant proper, the boiler room is in a building of its own apart from

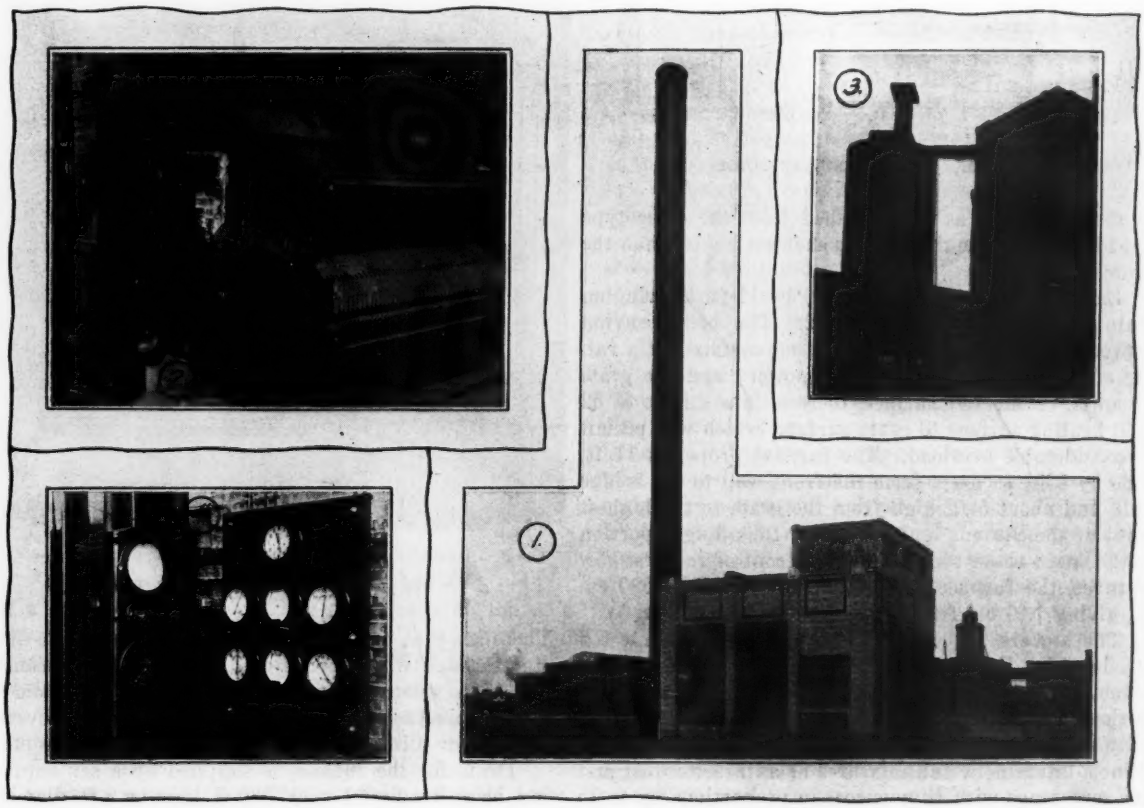


FIG. 1. BOILER PLANT OF THE WATERWAY PAPER PRODUCTS CO. FIG. 2. HARRINGTON CHAIN GRATE STOKER WITH ITS DIRECT CONNECTED DRIVE. FIG. 3. ASH HOPPER. FIG. 4. GAGE BOARD AND FEED WATER METER

the mill. This building, a view of which may be seen in Fig. 1, and a plan and elevation in Figs. 5 and 6, is a brick structure, 50 ft. long by 48½ ft. wide by 33 ft. high over the boilers, and 46 ft. high over the firing aisle. As there are but two boiler units, there is ample room provided and there is no suggestion of crowding at any point. As may also be seen in Fig. 1, three walls of the building are almost entirely glass and consequently there is always plenty of light, even on dark days.

The boiler installation consists of two 516-hp. Stirling units of the new type, class XII, the distinctive feature of which is that the three upper drums are all

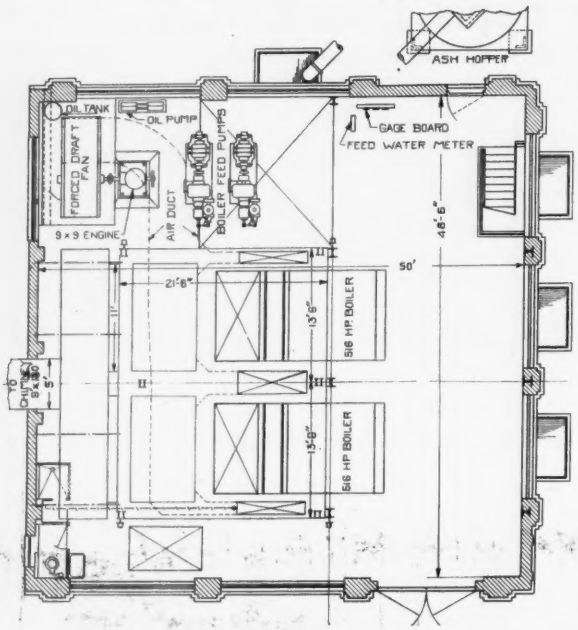


FIG. 5. PLAN OF BOILER ROOM

on the same level as distinguished from the older type in which the middle drum was somewhat higher than the other two.

Each unit is equipped with a 9 by 11-ft. Harrington chain stoker as shown in Fig. 2. The boiler having approximately 5160 sq. ft. of heating surface (at a rating of 10 sq. ft. per boiler horsepower) and the grate 99 sq. ft. of effective surface, there is thus a ratio of 52 to 1, heating surface to grate surface, which will permit of considerable overload. The furnace proper is 11 ft. wide by 12¾ ft. deep, from the front wall to the bridge wall, and about 5 ft. high from the grate to the highest point of the Stevens ignition arch. Including a portion of the space above the arch and in front of the first row of tubes, the furnace volume amounts to about 850 cu. ft., giving 1.65 cu. ft. per rated boiler horsepower.

The stokers are each driven by a direct-connected 4½ by 4-in. Engberg engine operating through worm reduction gearing. During the past few months, owing to the coal situation, these stokers have burned successfully many kinds of coal, including unusually low grade Illinois bituminous and mixtures of anthracite dust and fine screenings with Illinois coal in proportions up to 75 per cent anthracite. Inasmuch as the anthracite has practically the same heating value as the Illinois coal and was purchased for less than half the price, the economic advantage of operating on this mixture has been considerable. In addition, the plant was able to operate at times when it was impossible to obtain enough Illinois coal to keep running. This stoker with its non-sifting grate was found to handle the dust and fine screenings practically without siftings. The stoker is designed to operate continuously up to 200 per cent rating burning low grade Illinois coals. At the present time, the load conditions of the mill require about 175 per cent rating on one unit in service. Under present summer operating conditions the consumption is from 30 to 35 T. a day, operating 24 hr. a day and 6 days a week.

Coal is delivered to the plant by rail and is unloaded in the yard adjacent to the boiler house. From here it is wheeled in by barrow and piled on the floor in front of the boilers, from which the stoker hoppers are filled by hand. This is the practice at present. Future designs call for an overhead bunker, for which space has been provided; down spouts to the stoker hoppers; and mechanical handling throughout.

Ash is deposited from the end of the grate into an ash hopper beneath. From here it is raked out into a Brady steam jet ash conveyor which carries it to a large elevated bin immediately outside the boiler room. This conveyor runs along in front of the clean-out doors, directly beneath the firing aisle to the east wall of the building where there is a riser. Another short horizontal run connects to the ash bin, shown in Fig. 3.

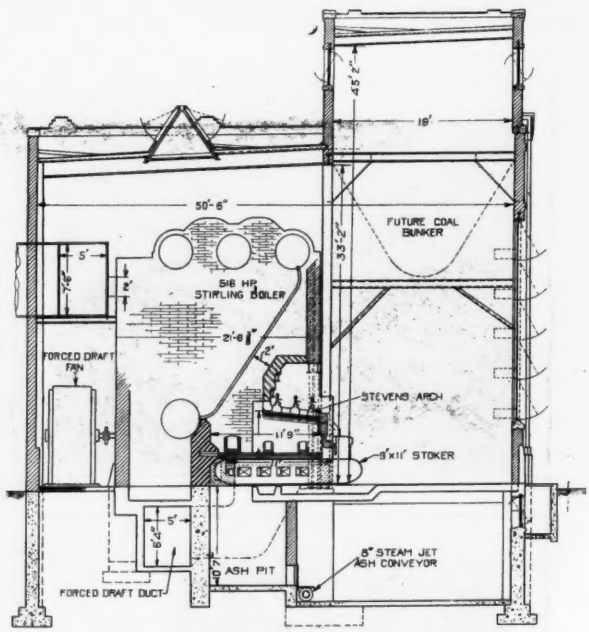


FIG. 6. SECTION OF BOILER ROOM

There are thus two bends. The line is 8 in. inside diameter through which ash is readily handled by means of one ⅝-in. steam jet at the base of the riser. From the storage bin the ash is dropped into a truck below and is used for filling purposes on the company's property.

Draft for the furnace is supplied by a self-supporting, brick lined steel stack, 180 ft. high by 9 ft. diameter, and by a Clarage forced draft fan. The wheel is 4 ft. wide by 8 ft. diameter and has 8 curved blades. At maximum rating, it is capable of delivering 30,000 cu.

ft. per min. at 5-in. water static pressure at the fan. At this rating it runs at 320 r.p.m. and requires 39 hp. This power is supplied by a direct connected 9 by 9-in. vertical steam engine, operating on 165 lb. pressure. At maximum rating, the fan is able to supply air for both boilers, each operating at 200 per cent of rating. The air is delivered through a 4 by 4-ft. opening at the fan through a duct under the floor to the wind boxes under each grate.

Combustion Control

Combustion is controlled by means of a Carrick combustion control system which is actuated by steam pressure at the boiler. Pressure on a mercury reservoir forces the mercury into a long cylinder in which there is a float or so-called plunger. In this cylinder the mercury stands at a known height for a given steam pressure that is to be maintained constant. The plunger moves up a distance of 1/32 in. for an increase in pressure of approximately 1/64 lb. When this plunger raises it lifts, by means of a connecting cable, the spindle

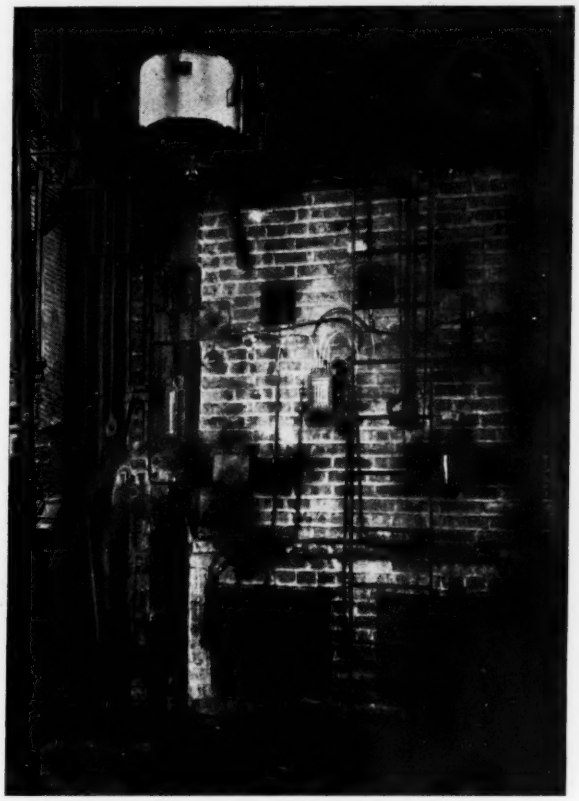


FIG. 7. CARRICK COMBUSTION CONTROL

of a four-way valve admitting oil pressure on top of a plunger having a stroke of 12 in. This cylinder in descending lowers the valve spindle and cuts off the oil pressure unless there is a continued rise in the steam pressure. Thus the movement of the oil plunger is gradual and its position is proportional to the boiler pressure at all times. The plunger acting under 90 lb. oil pressure is capable of exerting a considerable force. The movement of this master plunger is communicated through cables to three chronometer valves, one on each stoker engine and one on the fan engine, which control the amount of steam admitted to these engines, therefore the speed of the stoker and the air delivered by the fan.

Damper position is controlled by an independent system. Mounted on the side wall of each boiler, as shown in Fig. 7, is a cylindrical vessel in which there is an inverted bell under an oil seal. The space under the bell is connected with the furnace by a rather large air-tight pipe. This pipe projects into the furnace wall at a point about 3 ft. above the grate. The pressure under the bell is therefore that obtaining in the furnace.

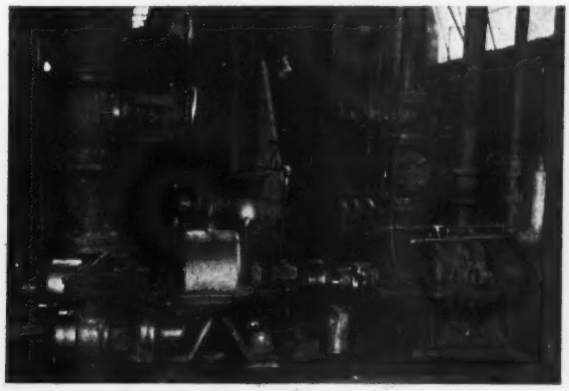


FIG. 8. BOILER FEED PUMPS

The pressure above is of course atmospheric. The bell is counterbalanced so as to be in equilibrium under any predetermined pressure over the fire which in this case is atmospheric. If a pressure builds up in the furnace, the bell rises and by operating a pilot valve to an oil plunger as in the case of the steam pressure controlled system admits oil pressure to the plunger which opens the damper in the uptake. The movement of the damper, as of the steam valves for the stoker and fan engines, is gradual and is always directly proportional to variations in furnace pressure. A large indicator on the wall at the east end of the firing aisle, shown in Fig. 9, indicates at all times the exact position of the damper and is thus an indication to the fireman as to what is taking place in his furnace.

Oil under a pressure of 90 lb. per sq. in. is supplied for the operation of the master and all chronometer valves by a 2¼ by 1 by 3-in. Gardner direct acting duplex steam pump located on the east wall of the building. It takes its supply from a cylindrical oil tank alongside, to which is piped the returns from the various plungers and valves.

As a check on the furnace conditions there is mounted on the side wall of each boiler a set of draft gages, four showing the pressure in each of the four wind boxes under the grate, one showing the draft or pressure over the fire and one showing the draft at the last pass.

For ordinary summer operation, carrying about 25 per cent overload with a fuel bed 7 in. thick, the windbox pressure is maintained at about 1 in. of water.

Feed water is introduced into the boiler at the upper rear drum, and is supplied by either one of two duplicate Allis-Chalmers 2½-in. 3-stage centrifugal pumps. Each pump has a capacity of 150 gal. per min. at a speed of 3500 r.p.m. under a head of 440 ft. or 190 lb.

This unit is direct connected to and is driven by a 40-hp. Moore turbine as shown in Fig. 8 and also in the plan of the boiler room, Fig. 5.

Steam for these turbines is taken direct from the header back of the boilers through a 2½-in. line. Suction for the pump is taken from a Reliance open induction type, 1000-hp. feed water heater, located on a platform directly overhead at an elevation of about 8 ft. above the pump inlet. Into this heater is discharged the condensate from the mill together with the necessary make up from the city mains. The whole is then heated to from 206 to 210 deg. by the exhaust from the boiler room auxiliaries.

The rate of feed to the boilers is controlled by an S-C feed water regulator of recent design. In this apparatus, the height of water in a so-called generator which connects, at one end to the water space and at the other to the steam space in the boiler, determines the quantity of the actuating medium, water, which is in contact with the steam or relatively cool boiler water.

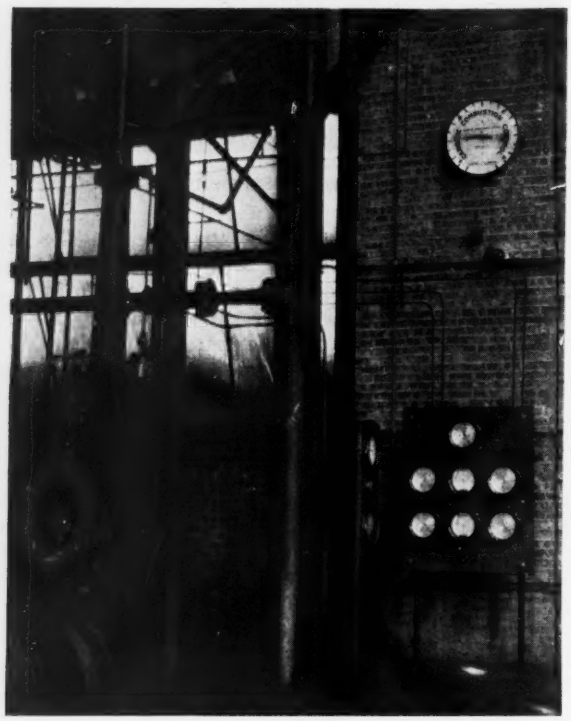


FIG. 9. GAGE BOARD AND DAMPER INDICATOR

This determines the temperature of the generator water and, in as much as it is confined, its volume also. When the water level in the boiler falls, there is more steam space in contact with the water in the generator and consequently this water experiences an increase in temperature and volume. This volumetric increase tends to increase the pressure which acts on a diaphragm controlling a balanced valve in the feed line. An increase in the generator pressure moves the diaphragm to open the valve and admit more water to the boiler.

Provision is made by the removal of soot deposits by the installation of a set of Diamond soot blowers on each boiler. Each set consists of six rotating units, one just above the lower drum in the first pass, one just below the upper front drum between the first and second passes, one below the middle drum in the second pass, one at about the center of the middle group of tubes, one below the last group of tubes, in the third pass, and one about half way up in this last group.

Each boiler is equipped with four 4-in. Lunkenheimer safety valves which are set to blow at 180 lb. These valves are adjusted for a 6-lb. blowdown; they are designed to discharge 7882 lb. of steam per hour, which is sufficient to take care of the full output of the boiler at 180 per cent rating.

Steam is generated at 175 lb. gage, dry and saturated. It is taken off through 6-in. wrought iron lap welded leads to an 8-in. extra heavy cast iron header supported on rollers, behind the boilers. From this header a 6-in. main runs down through the floor to the basement and thence through a connecting tunnel to the main building, a distance of perhaps 200 ft.

The total expansion and contraction in this length is a considerable amount and therefore there is provided an expansion "U" bend in the basement of the main building. This line as well as the other steam piping in the plant is at present without covering of any kind but it is expected that protection will be provided at an early date.

Considerable care has been taken to provide records and indications as to the performance of the boiler plant. Located in the walkway behind the boilers there are two indicating and recording Bailey steam flow meters,

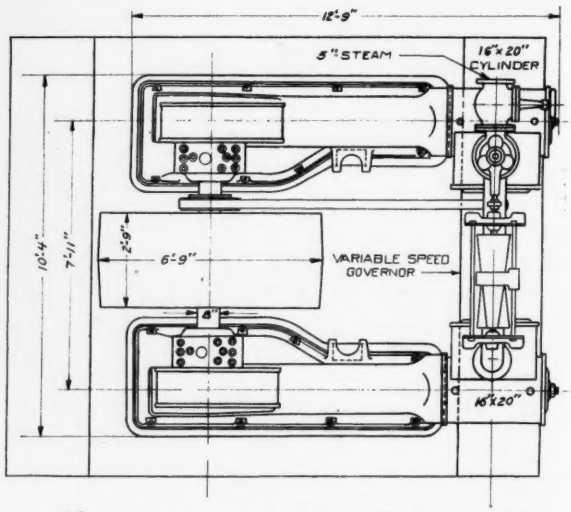


FIG. 10. PLAN OF VARIABLE SPEED ERIE BALL ENGINE

one connected into each of the two boiler leads. Here also are two Foxboro recording thermometers showing the temperature in the uptake from each boiler. At the present rate of production in the plant, the steam meters show an average of about 20,000 to 22,000 lb. of steam per hour. The thermometers record a flue gas temperature of about 500 deg. F. average. Located at the east end of the firing aisle against the wall is a board containing boiler and steam main pressure gages, a boiler pressure recording meter, a gage indicating the back pressure on the system, a city water pressure gage and a feed water temperature recording meter. Here also is a Bailey indicating and recording Venturi feed water meter which connects into the 4-in. feed

water line. This meter serves as a check on the steam flow meters as integrated over a period of time as for instance an hour or two.

Engines

Power is supplied for the operation of the one paper machine in the plant by two Erie Ball engines located in the basement of the building. The power requirements for a paper mill are unique in that for the manufacture of various grades of paper a variable speed drive is necessary and also for a given product a constant speed is required. Various methods have been used to meet these demands including constant speed engines operating through a nest of gears and variable speed electric drive. The first has been found unsuitable because considerable quantities of exhaust steam are required in the process. In this plant a variable speed engine, a plan of which is shown in Fig. 10, is used. Variations in speed are obtained by a simple adjustment of the engine governor while the engine is in operation. Aside from its chief function of furnishing power, the engine acts as a reducing valve between the boilers and dryers. Under these circumstances the cost of steam chargeable to the engine is reduced to a minimum. The engine, a two-cylinder simple slide valve machine having cylinders 16 by 20 in. and rated at 300 hp. at 220 r.p.m. is of the side crank type with the combination flywheel and driving pulley in the center. It takes steam at 165 lb. gage pressure and exhausts directly into the dryers at a pressure of 15 lb. gage.

The governor, which is of the flyball type operating a balanced valve in the steam line, is driven through a set of cone pulleys. By varying the position of the belt on these pulleys, any desired speed may be maintained.

The engine is belted to a line shaft running the length of the building. Vertical belt drives from this shaft deliver the power, at a number of points, to the rolls, which are all geared together on the machine directly above. In as much as all the rolls are geared together, it is of course necessary that the several pulleys driven from the shaft in the basement also run at the same speed. To this end, both driven and driving pulleys are made with a slight taper so that minute speed adjustments may be made simply by shifting the belt.

The other engine is a single cylinder simple slide valve machine. It has a cylinder 12 by 20 in. and develops 100 hp. at rated load. It is used to drive the several pumps used in the plant and also to drive the screens, a part of the paper machine whose function it is to keep the pulp fibers free from dirt and foreign substances. This engine operates at constant speed; its exhaust is added to that of the first engine and delivered to the dryers.

Condensate from the dryers as well as that from the steam separators at the engines is returned through Fisher steam traps to the feed water heater in the boiler room.

For the courtesy and assistance extended to us in the gathering of material for the preparation of this article we are indebted to Frank D. Chase, Inc., who were the designing and consulting engineers on the job, and to Mr. Mendelson and Mr. Daly of the Waterway Paper Products Co.

Grates for Moist Fuel

Practical and Theoretical Considerations Involved in the Design and Operation of Grates for Burning Moist Fuel. By Zuce Kogan

Grates for fuel of high moisture content are exceedingly difficult to design and apply due to the usual extinguishing of fire under improper conditions of burning and to the difficulties in cleaning the fire of hard, sticking clinker. Nowadays, however, a large variety of grates are manufactured differing widely in their design and construction, varying greatly in their installation, and even with the manner of charging the fuel. All these conditions bring forth a great many advantages and disadvantages with any of the arrangements, and the question of choice and proper application of grates remains a quite difficult task.

In considering the grates for use with moist fuels, an unsuitable choice, careless installation, and improper method of feeding results in such conditions that not only would the fire burn uneconomically and smolder slowly but in many cases extinguish some portion of the fire. This latter being the worst fire condition is of most usual occurrence, i. e., it results with any low height of fuel bed that contains more than 55 per cent of moisture and under faulty furnace conditions. The reason for this occurrence is simply due to the improper draft arrangement under the grate.

Draft is well known to take the passage of least resistance, the moist fuel being light and loosely charged, and therefore if one portion of the grate is insufficiently charged with fuel, the air begins to flow excessively, and the resulting rush of cold air on the very moist fuel, ends in extinguishing the fire on this portion of grate. The uneconomical combustion is too well known to be mentioned, while at the same time this gives difficulties for meeting the demand for steam. These disadvantages are easily curable either by varying the grate proper or the installation or the method of charging the fuel. In order to refer to the possibilities of efficient combustion through adapting these methods, it will be important to give some account of the grates used with moist fuels.

Ordinary Horizontal Grate

The ordinary horizontal hand fired grate is the earliest type used for burning the moist fuels. It gradually went out of practice and is now used to a less extent, due principally to two causes. First, the high moist fuels are light in their weight and therefore require a thicker fuel bed for a given quantity of calories per grate area. The fuel charged on the grate cannot be well dried, as the fuel bed is usually too thick. To charge the fuel in thinner fuel layers and to increase the grate area, results in still worse conditions, as the draft is more apt to find an easy path between the thin layers of fuel and to extinguish it, thus preventing it again from drying. The next important disadvantage of a horizontal grate is the difficulty in cleaning. These fuels generally produce a hard and sticky clinker that

is very difficult to remove, while the practice of applying exhaust steam for the easy removal of clinker was found to be impractical here.

These disadvantages which were thought incurable have been reduced to a very great extent by changing the manner of charging the fuel. The conical method of feeding was such a success that many combustion engineers use the horizontal grate and obtain good results. Figure 1 illustrates a modern furnace for moist fuel and method of charging. In this case the upper layer of fuel being the fresh or most moist, takes the form of a cone;

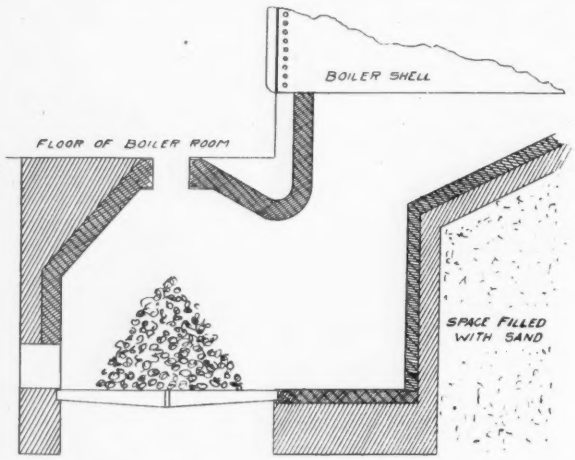


FIG. 1. FLAT GRATE FURNACE FOR MOIST FUELS

its surface is thus greater than it would be if the surface were a horizontal layer, while the point of the cone is well affected by the heat of the furnace. The extinguishing of fire cannot exist in here as the fuel bed is quite heavy, while the fire resulting from the combustion of inclined fuel surface of the fuel cone, is ready to consume any quantity of air that will be able to pass through the grates around the cones. Moreover, greater advantages are gained when the air will enter at the end of the cones because it is of usual practice with high moist fuels to allow the whole air supply to enter under the fuel bed itself, thus this extra air which does not pass the fuel but comes in direct contact with the flame is of advantage. Generally speaking, this method has shown good results and efficient working, but depends to a large extent on the special arrangement of furnace brickwork and sufficiently large combustion chambers.

Inclined Grates

In criticism of horizontal grates from the viewpoint of efficient working, consider for example the two fuel beds shown in Figs. 2 and 3. The first being of uniform fuel bed gives a uniform fire above the grate and the gases therefore easily pass through the bridgewall, due to this uniform heat above the fuel bed; but in Fig. 3 where the layer of fuel is lower near the bridgewall, a higher temperature of flame is produced at this end because the top flame resulting from the lower fuel bed is the hottest, and this hot flame guards against any gases of incomplete combustion escaping through the passage at the bridgewall. As this latter type assures a more thorough combustion with a greater efficiency, it therefore was thought to be well suited to moist fuels, but unfortunately this was found still defective for a good many reasons. In this case the fuel at the bridgewall being of a much thinner layer, a large amount of air passes through this part of the bed, due to its being the path of least resistance. This gives rise to the occurrence of extinguished fuel or improper combustion at the bridgewall, while our whole aim was that this part of the grate acting as a guard should be at its most efficient burning or hottest flame.

Another important thing is that when our firemen are instructed to use such a method of charging, they will always, because of insufficient ability or attention, leave some part of the grate near the bridgewall completely uncharged, as shown in Fig. 4, which will not only reduce the effect of preventing the gases not thoroughly burned from passing the bridgewall, but will, as is well known, permit the rush of air to reduce the efficiency to minimum due to chilling of gases, boiler shell and brickwork.

Referring again to the practice of maintaining a low fuel bed at the end of the grate, we know it to be of value due to the production of an intense flame of a dense nature which obviates any gases to pass unburned.

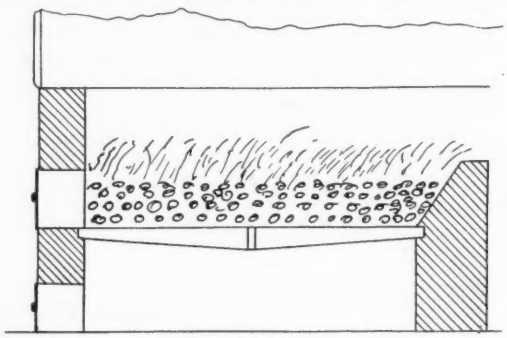


FIG. 2

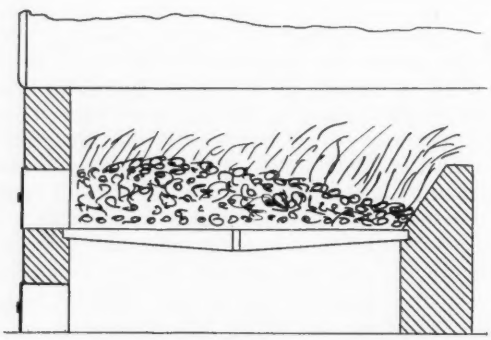


FIG. 3

FIG. 2. GRATE WITH UNIFORM FUEL BED

FIG. 3. GRATE WITH FUEL BED LOWER NEAR BRIDGEWALL THAN IN FRONT OF FURNACE

Now not only does a low moist fuel bed burn with insufficient intensity but it also fails to produce an ample fire for covering the whole space of this passage. This is due simply to the fact that more than twice the weight of moist fuel will be required to give the same heat as coal, furthermore, the volume of the moist fuel is much greater as compared with coal. Now the question arises, what flame does guard the gases when a low layer of moist fuel is used From a careful con-

sideration of the foregoing factors it is apparent that moist fuel needs a thick layer of fuel near the bridgewall and this can only successfully be obtained with an inclined grate.

The Requirements to Be Fulfilled

The advantage of assuring more complete combustion of the gases, and the facilitating of the process of cleaning, led to the practical adaptability of the inclined grate. Moreover, as these grates vary to a greater range in their design and application the suitable choice and arrangement could be more readily obtained with them than with horizontal grates. These grates were not highly successful in their earliest application, but their development has progressed with the study of their noteworthy features in accordance with the requirements of moist fuels. One of the earliest applications

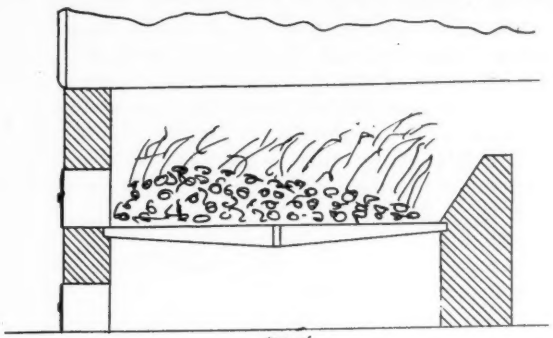


FIG. 4

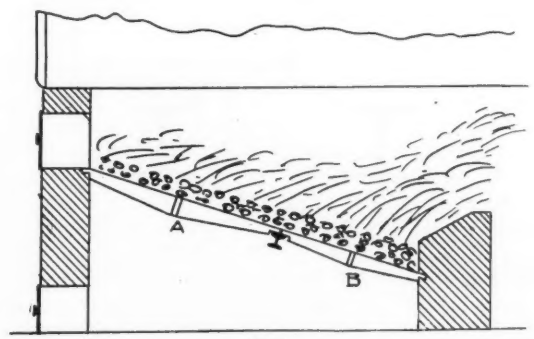


FIG. 5

FIG. 4. DIAGRAM SHOWING TENDENCY OF FIREMAN TO LEAVE A PORTION OF THE GRATE UNCHARGED

FIG. 5. ONE OF THE EARLIEST APPLICATIONS OF THE INCLINED GRATE

of the inclined grate is shown in Fig. 5. As it was of interest to dry the fuel as much as possible before its ignition took place, the moist fuel was placed on the first grate in order to utilize some of the heat from the furnace to drive out its moisture. The grate A was therefore designed with smaller air spaces than those of grate B. On the other hand, as it is required to have the most efficient combustion and the hottest flame near the bridgewall, the fuel as it dried out on the grate A was pushed on that of B, where its drier nature produced better combustion and a sufficiently hot flame for consuming the gases escaping at the bridgewall passage. Grate A was made larger than B so that the whole fuel from this grate pushed on B will produce a thicker layer of fuel at this end.

The advantage of making grate A larger than B is also of importance, as this also permits the given quantity of moist fuel to be spread in thinner layers than with the smaller grate and the thinner the layers the more effective is the drying. Considering this grate from another point of view, however, we find practically as well as theoretically that it is still far from being economically correct. The reasons are too numerous to be mentioned, but some important ones will be briefly referred to.

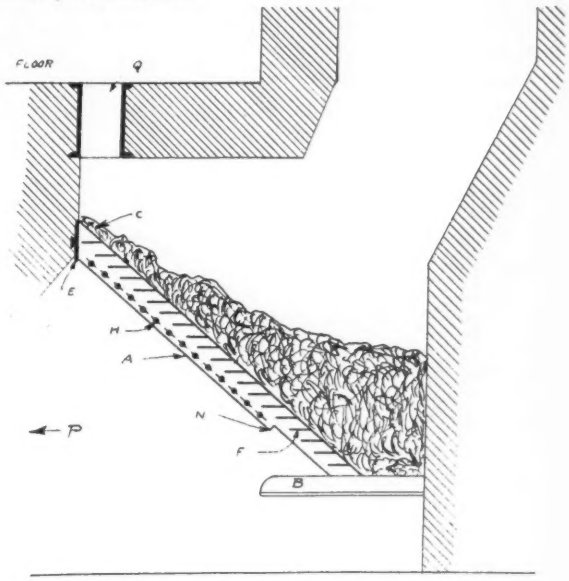


FIG. 6. MODERN GRATE WELL ADAPTED TO THE USE OF MOIST FUELS

First the moist fuel does not comply with the same regulations that ordinary coal fuel does, both because of the high moisture content and because of the variability of this moisture content. For example, if we leave a heap of moist fuel, say of 55 per cent moisture content exposed to the atmosphere for one or two summer days, we find its upper surface or first layer to be reduced to 50 or 45 per cent. In fact, with any kind of moist fuel the per cent of moisture contained today is not the same as that obtained yesterday. We cannot, therefore, expect our moist fuel to be of uniform wetness. Now, taking this into account and considering the effect of draft or air passing under the grate and rushing through the moist fuel, it is obvious that the draft will have to be regulated according to the wetness of the fuel when maximum efficiency is required.

Second, since the thinner the layer of the fuel spread on the grate A, the more the heat will be absorbed by a given quantity of it, if we now refer to the factors already pointed out, that the quantity of moist fuel must be greater than that of coal when compared as to their equivalence in calorific power and weight for weight, we can easily see that to maintain a thin layer we would have to maintain continuous charging. This, of course, is impractical with this grate.

Third, the drying of fuel on which economy of combustion mostly depends is affected to a great extent by the time it remains in contact with the heat of the furnace. With the inclined grate the necessity for fre-

quent charging, shortens the intervals of drying on grate A before being pushed on grate B.

Considering that the furnace is required to evaporate a certain quantity of steam, this would then require a certain amount of heat. Now, to obtain this necessary quantity of heat units from moist fuels, the volume of the fuel will be great as compared with other fuels. On the other hand, the height of the fuel bed on the grate is limited, and the grate must also be increased to meet at least 100 to 200 per cent of rating. What size of grate area, then, must we provide with the moist fuel and what combustion chamber volume must we provide with such grates of moist fuel?

These are a few of the questions that had to be solved before an efficient method of utilizing these fuels

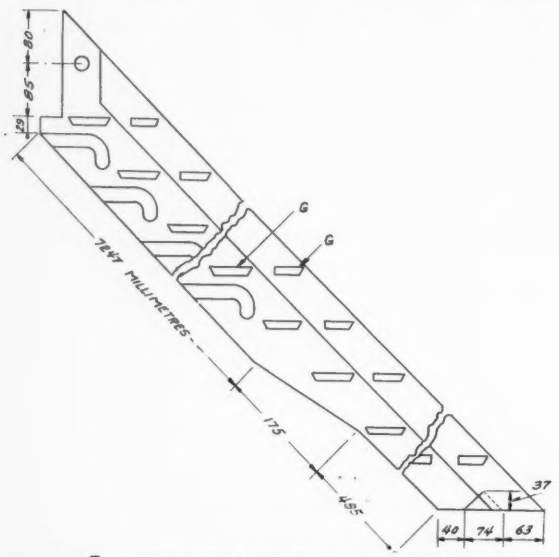


FIG. 7. SUPPORTING BARS FOR INCLINED GRATE

was developed, and we will therefore refer to one of the modern grates in which all these troubles were overcome to a very great extent.

A Suitable Grate

A MODERN GRATE that adapts itself quite well to the requirements of the moist fuel is illustrated in the scheme, Fig. 6. Before pointing out how this meets best the utilization of this fuel, it will be interesting to give some account of its design and installation. It consists of two separate grates, the inclined grate A and the horizontal grate B. The inclined grate generally consists of three of four supporting bars, C, which are generally installed at an inclination from 45 to 50 deg. These are fitted on top to the cross bar, E, and rest at its lower end on the horizontal grate, B. These bars, illustrated in Fig. 7, have grooves for fitting of gratings or draft doors.

The gratings, F, Fig. 8, fit the grooves, G, Fig. 7, and are so arranged that they can be easily removed from their position by hand. These gratings are usually from 15 to 25 in number according to the nature of installation. The draft doors H, shown in Fig. 9, fit grooves in the supporting bars and cover the air entrance between successive gratings. These vary in number from 10 to 20 and can be very easily adjusted to suit any amount of air entrance between the gratings.

The horizontal grate B, shown separately in Fig. 10, consists of two or three fixed fire bars and a number of movable bars which slide through their slots K on the round bar L and the supports of M and N.

The Suitable Features

CONSIDERING THIS grate as described, it may be said that it has successfully burnt fuel of 53 per cent moisture with a CO_2 of 17. It also simplified the adjustment of furnace for the different moisture contents of fuel, reduced the space to a great extent, and obviated many difficulties met in cleaning. In order to consider how these results have been obtained, it will be interesting to mention the special features embracing its design, installation, and operation. Taking into account the draft and its arrangement for the prevention of the action of cold air on the moist fuel, it is evident that the draft doors H between the gratings make it possible to regulate the air in the manner to suit best the particular moisture content of the fuel. The portion BN of the grate has no doors at all because at this portion of grate the fuel bed is very heavily charged thus giving great resistance to the passage of air, while the quantity of air that forcibly passes this portion of grate makes it advantageous to combustion, but in general the draft is

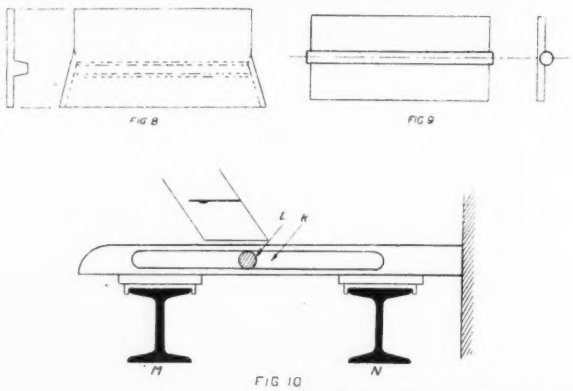


FIG. 8. GRATINGS FOR INCLINED GRATE SHOWN IN FIG. 6
FIG. 9. DRAFT DOOR
FIG. 10. HORIZONTAL GRATE OF FURNACE SHOWN IN FIG. 6

independent of that passing under the grate, as the additional supply of air necessary to maintain the required draft, is supplied through a special air regulator placed at the hopper O. Most of the air that will not greatly affect the moist fuel is supplied under the grate, while the rest is supplied just above it.

Considering now the drying of fuel, it will be noticed that the grates are well inclined and the fuel falling on them will tend to slide down as the fuel bed is consumed. While the bed is being consumed, it will remain at the upper portion of the grate, in the meantime absorbing the heat of the furnace for drying its moisture. Now to dry the fuel effectively, two things were required, first, exposure of the fuel in thin layers and second, exposure for the greatest length of time. This grate permits us to secure both requirements at the same time. The grate is designed with a number of small gratings so that the total surface of the grate is increased in the same manner as the surface of a boiler shell is increased by its corrugated shape. The increase in surface exposes the fuel in thinner layers. Furthermore the grate is

very long and inclined and as is well understood, the longer the grate the longer the path for the fuel to travel within the furnace. Also, the smaller the inclination of the grate the more slowly the fuel descends and the greater is the time of drying. Generally speaking, the grates must be considerably inclined, in order to obviate the constant charging as met with in the installation shown in Fig. 5; but in order to give the fuel the necessary inclination to meet the requirement for slow movement in the furnace, an inclination varying from 45 to 50 deg. is recommended.

With regard to space economy, it is evident that the long grate fitted in an inclined position would always require less space than if placed horizontally; moreover, the whole furnace is installed below the floorline. This latter feature also reduces the radiation losses. In short, this arrangement does not require any more boiler room space than that occupied by an ordinary boiler installation.

Considering its operation, the fuel for charging the boiler may be managed by a man who has no knowledge of firing. The hopper is on a level with the floor of the boiler room and it is, therefore, merely necessary that the fuel be pushed through it. The cleaning, breaking up, etc., is performed from the underground passage P, and does not interfere with keeping the boiler room neat and clean. The cleaning is conveniently done by removing some of the draft doors and gratings and pulling out the horizontal grate bars.

Guarantees and Testimonials

By George H. Wallace

FEW ENGINEERS there are who have not at some time been annoyed by a persistent, tactless representative of some maker of power plant specialties and supplies, who breezes in with the assertion that his particular device or goods will save the engineer 10, 20 or 50 per cent of something or other,—cost, time, trouble or language. A striking example came to the writer's attention some time ago in a plant where he was working on a repair job. In came Mr. Salesman and without even a glance at the size of the plant or its equipment, exploded the statement at the engineer, "I can save you a hundred dollars a year on your oil bill."

Old Ezra, the engineer, rushed forward to grasp the salesman's hand, saying, "I have been engineer here for 25 yr., and you are the very fellow I have been looking for all the time. We are always anxious to economize. Come right over here to the desk and write out a contract for 5 yr., to save us $100 a year on the basis of the average oil bill for the past 5 yr."

Then the salesman tried to hedge, but Ezra insisted that he wanted to save $100, and finally the oil man "took water" on his assertion, also took his departure.

"That makes 37," said Ezra as he came over to me. "Thirty-seven what?" I asked. "Why, 37 salesmen who crawfished. Every few months one wants to save us a lot of money, and when I ask for a written contract he doesn't make good. That fellow was going to save us $100 a year on oil, and our average oil bill for 5 yr. past has been a little over $56."

Most salesmen aren't like that. It is only because the "so-different" ones stand out that they are noticeable, but it's a good idea to call their bluff.

Follow-up calls on requests for catalogs are, also, sometimes annoying. Often an engineer, having in mind some future development, wants information on some apparatus and sends for a catalog. He wants to study it, to file it for reference, and likely, later, to buy. But, sometimes, on the heels of the desired information, or even in advance of it, comes a representative of the manufacturer keen for a sale, and insistent to close the deal, before there has been time for study of the equipment or comparison of various types. Even worse, if the engineer has given his firm's name as an evidence of good faith in requesting a catalog, the salesman may go after the purchasing agent or an officer of the firm who knows nothing of what the engineer is considering. This may result in friction all around.

The manufacturer naturally asks, "Can you blame us if we are eager to follow up an inquiry?" Certainly I do not. They would be foolish to sit back in their offices and wait for orders to come by mail. But it might be wise to find out by letter whether a call from a salesman would be welcome. And the engineer could help a lot, if when writing for information, he gave some idea as to when he would be in the market for a purchase and whom the salesman should see. Also, if he doesn't want to be seen, he could easily state that he would write again when he was ready for a call.

On the other hand, engineers are often not as appreciative of courtesies from manufacturers as they might be. When a catalog has been requested and received, a simple expression of thanks is surely due. And when apparatus or supplies are giving good results, it is a great satisfaction to the manufacturers to know it. We are quick to complain if performance is not what we expect, and most manufacturers are anxious to give all possible assistance in getting things right. When equipment is doing noticeably well, why not let the maker know?

But again, sometimes when this has been done, back it comes as a boomerang to bump the engineer. His letter and a picture of the apparatus, possibly of his installation, his plant or the entire works, have been exploited in widespread advertising without permission and maybe in a way countenanced by his employer.

As an instance, the writer at one time had certain equipment in use for a long time and working so well that he felt the maker would be pleased to know the results, so wrote a letter from his home, giving the facts and stating his position and the firm for which he worked. In a few days appeared, unannounced, a photographer with a quantity of equipment and orders to take pictures of the apparatus, the engine room, the plant, the works, and the writer, all for advertising purposes. Naturally my employer was annoyed; but the explanation was satisfactory to him, though the photographer went away empty handed. If I had surmised what action the maker of equipment would take, I should either have refrained from writing him, or cautioned him that the testimonial was not for publication without permission. Or, if he had written for permission to use it with pictures, I might have been able to arrange with my employer beforehand, and saved the loss in "artist's fees."

So don't be afraid to let a man know when his goods are satisfactory, but caution him about use of the letter without special permission.

British Practice in Waste Heat Utilization

REMARKABLY EFFICIENT GAS FIRED BOILERS FIND MANY APPLICATIONS IN THESE TIMES OF HIGH FUEL COSTS. BY C. H. S. TUPHOLME

THE POSSIBILITIES of waste heat utilization as a means to fuel economy is receiving considerable attention at the present time in Great Britain. In this connection some interesting information on waste heat boilers was given recently to the West of Scotland Iron and Steel Institute by P. St. G. Kirke of Spencer Bonecourt, Ltd., one of Britain's leading manufacturers of waste heat boilers.

The first waste heat boiler was known as the Hopwood boiler, invented in 1886 by John Henry Hopwood. He was interested in the manufacture of ordinary vertical cross-tube boilers, which he improved by eliminating the ordinary cross tubes and fitting in their place a number of parallel water tubes. It was, however, only possible in those days to make very small boilers because the breadth of the nest of water tubes was limited by the size of the manhole through which they were inserted. Consequently, though a number were built, very little was heard of them. A. L. H. Spencer greatly improved the old Hopwood boiler, enabling them to be made in larger sizes.

Instead of having two manholes, one on each side of the boiler, exactly opposite one another, Spencer staggered the manholes relative to one another, and by inserting half his nest of water-tubes through one manhole in one direction, and the other half of his nest through the other manhole in the opposite direction, he permitted the water tube nest to be doubled in width. As a result, larger boilers were constructed and have proved successful.

These improvements enabled boilers to be made up to 5 ft. 6 in. in diameter, though this was somewhat large for a nest of water tubes controlled by only two manholes even of the large size obtainable today.

One of the most important features of the boiler is that, when fired with coal, steam can be raised from cold water to 100 lb. pressure in 35 min. from lighting the fire with no risk whatever to the boiler. No leakage is induced by this rapid steam raising, even though it is done every day.

An interesting feature, and one often lost sight of, is the small size of the boiler for the evaporation; for a boiler only 3½ ft. in diameter and 7½ ft. high, with a 5-ft. chimney, evaporates, when fired with coal, 700 lb. of steam from and at 212 deg. F. per hr. easily, and with a little steam jet in the uptake this can be raised to 1000 lb. from and at 212 deg. F. per hr. and over, without forcing the boiler, which is about 50 per cent more than can be obtained from an ordinary vertical cross-tube boiler. Again, one of these boilers 5½ ft. in diameter, and only 12 ft. high, will evaporate with a 5-ft. chimney, when fired with oil, 3000 lb. of steam from and at 212 deg. F. per hr., which can be increased to 4000 lb. from and at 212 deg. F. per hr. with a steam jet. That is more than double the evaporation of an ordinary vertical cross-tube boiler 5 ft. diameter by 13 ft. high. The combustion of the fuel in these boilers is extremely good, which is probably due to the fact that products of combustion are drawn evenly off the surface of the fire and not at one side as in the case of boilers of the Lancashire and several other types.

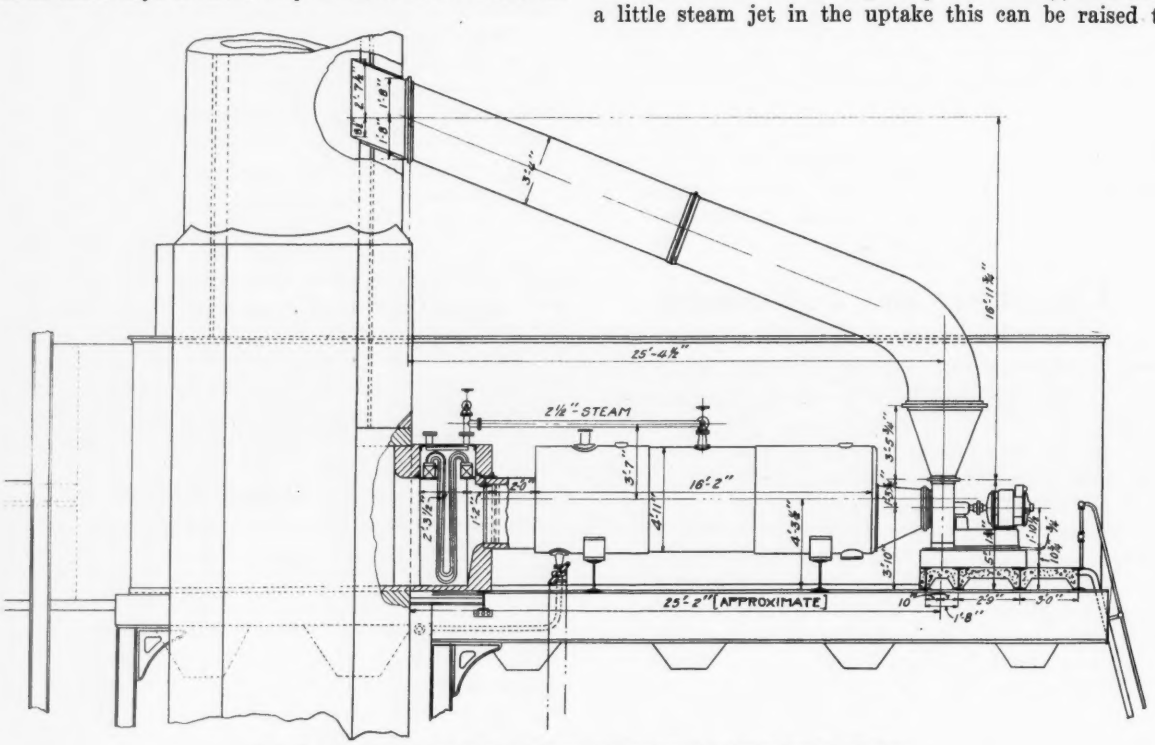


FIG. 1. DIAGRAM OF THE SPENCER-BONECOURT WASTE HEAT BOILER

Boiler Is Suitable for Waste Heat Work

The foregoing remarks have been leading up to the new improved Spencer-Hopwood deep nest boiler. This new improved boiler is very suitable for many purposes for which the ordinary patterns were not suitable. For example, they may be fitted to industrial furnaces discharging gases at very high temperatures, such as puddling furnaces, water gas plants (where there is an immense amount of waste heat), soaking pits, and gas works retorts. If this type of boiler is applied to the recovery of waste heat it can be fired with coal or oil when there is no waste heat, and it is not difficult to arrange it to fire with oil or coal and waste heat simultaneously.

Lastly, by using more than two manholes per row of manholes, the tube nests can be made any desired width, so that there is now nothing to prevent these boilers being made for evaporations up to 10,000 lb. of steam per hr. In other words, they can be built to do the work of a Lancashire boiler, and give as high an efficiency, without the floor space, without the brick setting, without the chimney, and without the necessity of raising steam slowly. In short, they have the best points of both the water tube type of boiler and the drum type of boiler without many of the disadvantages of either of these types.

In this connection it may be of interest to refer to the work of Professor W. A. Bone. Although Prof. Bone was not a boiler expert, he, with the assistance of the late Lieut. C. D. McCourt, produced an historic boiler having a thermal efficiency with the economizer of 92½ per cent unlagged, and at the same time, an average evaporation of 15 lb. of steam from and at 212 deg. F. per hr. per sq. ft. of combined boiler and economizer heating surface. These results were perfectly astonishing at that time. Professor Bone led the way; he showed what could be done.

The first Bonecourt boiler put into commercial use was 10 ft. diameter by 4 ft. long, fired with clean coke oven gas. It evaporated 5000 lb. of steam from and at 212 deg. F. per hr. with an induced draft of 20 in. of water. Now the largest boiler a British railway can carry is 10 ft. diameter, and the demand was for boilers fired with coke oven gas to evaporate 20,000 lb. of steam per hr.—four times the capacity of the 10 ft. diameter boiler referred to. This was the first limitation. A second limitation to this boiler was that it ran with explosive mixtures. A third limitation was that for the evaporation stated 110 separate burners had to separately adjusted by eye each time the load varied.

The Kirke Patent Gas Fired Boiler

The new Kirke patent gas-fired boiler embodies the improvements which experience with the Bonecourt boiler has shown to be necessary. This design of boiler is based on the discovery that, if such gases as coal gas, coke oven gas, blur water gas, producer gas, or natural gas are induced into empty tubes of great length relative to their bore, together with the air theoretically required for combustion, or some 10 per cent in excess thereof, they can be completely burnt without being previously mixed, and the resulting products of combustion reduced to 70 deg. C. or less above the temperature of the water in the boiler. Further, that this can be done with natural draft or with high induced draft of 4 in. of water and over, provided that the length of the tubes is greater relatively to their bore the higher the draft adopted. This boiler in its simplest form consists of a drum traversed by a number of long empty tubes, which function as combustion chambers, as mixing chambers, and as extractors of the sensible heat remaining in the resulting products of combustion.

At the inlet end of the tube is a patent gas burner or distributor which discharges a jet of gas into each tube, the amount of which is determined by the size of the holes from which the gas issues and the pressure of the gas in the burner, the latter being controlled by the large gas inlet valve at the bottom of the burner. The requisite air for combustion enters each tube from the

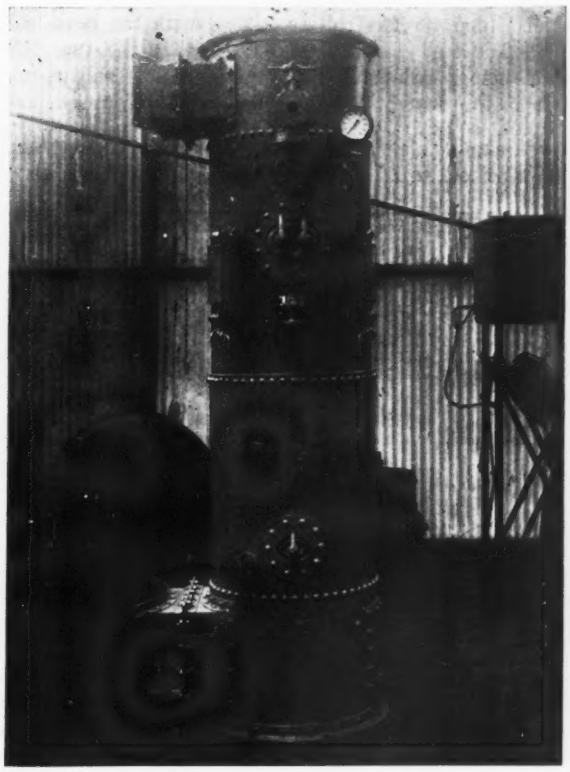


FIG. 2. SMALL SPENCER-BONECOURT WASTE HEAT BOILER FOR INSTALLATION IN CONNECTION WITH GLOVER WEST RETORTS

atmosphere, the quantity being controlled by the amount of draft, which is varied to suit the load.

Below are figures obtained from a single tube evaporating water in an open wood tank lined with zinc:

Gas burnt in cubic feet per hour	230
Steam raised from and at 212 deg. F. in lb. per hr.	104
Cubic feet of gas per lb. of steam from and at 212 deg. F.	2.21
Temperature of gases leaving the boiler, deg. C.	188
Suction in inches of water	8
Gas pressure in inches of water	4
Evaporation per square foot of heating surface in lb. from and at 212 deg. F. per hr	18
Net calorific value of the gas in B.t.u.	480
Thermal efficiency without economizer, per cent.	91

A single-drum boiler of this type, 7 ft. diameter by 21 ft. long, fired with coke oven gas, will evaporate

21,000 lb. of steam per hr. with a suction of 4 in., 16,000 lb. with a suction of 2½ in., and 10,500 lb. with a suction of 1 in. The radiation lost from the shell when completely lagged (except for the front tube plate) is only ½ per cent at full load and under 3 per cent when unlagged.

The table gives the power required by the fan, assuming 15½ lb. of steam from and at 212 deg. F. are required to generate 1 b.hp.

Uses for Gas Fired Boiler

Many uses for these gas-fired boilers will occur at once to the reader, but there are one or two special cases which should be mentioned. An inquiry was received by the Spencer-Bonecourt Company recently which called for two boilers to deal with the peak load of 3000 kw. at a central electric station, the fuel proposed being coal gas. The peak only lasts about one hour in the day, but might come on at different hours,

POWER REQUIRED BY FAN, ASSUMING 15½ LB. STEAM FROM AND AT 212 DEG. ARE REQUIRED TO GENERATE 1 B.HP.

Nature of fuel	Draught	Percentage of boiler output required to create 4" suction.	Approximate B.H.P. required by the exhauster for an evaporation of 10,000 lbs. of steam from and at 212 deg.F per hour
Water gas. . ..	4	0.93%	6
Coke oven gas..	4	1 %	6½
Producer gas ..	4	1.25%	8
Crude oil	4	1.35%	8¾
Coal	4	1.71%	11
Blast furnace gas	4	2 %	13

so that stand-by losses for 23 hr. have to be taken into consideration. It was found that, with the price of coal gas offered, the cost would have not been at all prohibitive, while the absence of fuel storage, the small floor space occupied by the boilers (7 ft. by 21 ft., one drum above the other), the saving of labor, and the reserve of power obtainable at a minute's notice would have been very convenient. The substitution of producer or water gas for coal gas would naturally reduce the price of fuel very considerably.

Another boiler is now being installed in the heart of the city of London to burn hot uncleaned producer gas. Various kinds of fuel can be put into a suitable producer, and there is no smoke. The guaranteed efficiency of the producer is 85 per cent, that of the boiler 90 per cent, so that the overall efficiency of the two is 76½ per cent. Because there is no cleaning or cooling of the gas, the capital cost of the producer and boiler is not higher than that of an ordinary coal-fired boiler in this case.

The following are the approximate fuel consumptions per lb. of steam raised from and at 212 deg. F. for various fuels burnt in this boiler without economizers:

Producer gas .....8 cu. ft.
Coke-oven gas .....2½ cu. ft.
Water gas .....3⅝ cu. ft.
Rich coal gas .....2.2 cu. ft.
Poor coal gas .....2.7 cu. ft.
Natural gas .....1.2 cu. ft.
Crude oil .....1/17 lb.

There are two types of Kirke waste-heat boilers, one a very short or squat one for dealing with clean gases which are at a positive pressure exhausted from large gas engines or Diesel engines and an entirely different and very long one for dealing with dirty gases usually found at a negative pressure.

In the short or squat type for internal-combustion engines the tubes are very short, and in them are placed twisted metal spirals. This type has been evolved to obtain the many advantages which may be obtained with twisted spiral cores, the twisting of which to a sufficient degree requires special machinery and special material. A short vertical boiler for a fairly large gas engine which had been working for years was found to save its whole cost in twelve months.

A short boiler of the horizontal type, working with another gas engine, was found to raise the steam from cold in 30 minutes from the starting up of the engine.

The chief advantages of these short or squat gas-engine waste-heat boilers, besides the reduction in floor space, are as follows: There is a reduction in the amount of heating surface required and, consequently, in the amount of water to be heated before the steam is raised. The tubes are very easily cleaned on the water side, as they can be made quite large in diameter, even though the boiler is short. The cost of the boilers is low, and the efficiency is high. The life of the tubes is abnormally long.

In the long pattern Kirke patent waste-heat boiler, made for large industrial furnaces, there are no spirals placed in the tubes. By using a high velocity of flow through the tubes a small boiler can be made for a big output, and the capital cost kept low. The high velocity is compensated for by having the tubes very long relative to their bore, the length depending on the velocity chosen and the temperature of the hot gases entering the boiler. Tube efficiency is usually about 90 per cent, and can be raised to 95 per cent. In this way, the gases leaving the boiler are cool enough to enter the exhauster, the boiler being so efficient that in many cases it is hardly worth while going to the expense of installing an economizer at all. Except when the water in the boiler is cold, it is impossible for the gases leaving the boiler to corrode the tubes or the fan impeller, because the water in a steam boiler is always above 212 deg. F., and therefore, the steam in the products cannot condense and combine with any sulphur in the gases to form sulphuric acid. If an efficient boiler is installed, and an economizer inserted between the fan and the boiler, the gases may easily be reduced to such a temperature as to corrode both economizer and fan and stop the whole plant. For this reason, if an economizer is to be added, it should be put on the exhaust side of the fan, so that if the economizer is eaten away the boiler and fan remain intact. Again, supposing the gases entering the boiler are at a very low temperature and an inefficient boiler needing an economizer is installed, the waste heat in the gases leaving the boiler will often heat far more water in the economizer than the boiler can use.

During the first six months of 1922, according to information received by the Department of Commerce, French exports of iron ore reached 4,328,455 metric tons as against 2,666,428 tons during the first six months of 1921.

Commercial Value of Exhaust Steam---I

A Long Step Toward Preserving Our Coal Supply and Increasing Power Plant Efficiency. By Fred William Bosch

IT IS a strange fact that the average user of heat and power rarely, if ever, investigates the economical operation of this department of his business. Every other department may receive his close attention and study, but the heat and power department, as long as it does its allotted duty, is not given much consideration, and it is uncommon to find industrial plants where a saving of from 25 per cent to 75 per cent could not be effected.

The owner is not altogether to blame for his power-plant inefficiency, as the manufacture and transmission of steam is an invisible process—in boilers and pipes, and the lack of reliable means, until recent years, for measuring the flow of steam is responsible for the habit of neglecting this department.

Since the introduction of the high efficiency steam turbine and the internal combustion engine, it has been stated that the steam engine will be wiped from the industrial field as completely as the American buffalo has been from the prairies of the West. This is undoubtedly true of the very large engines, especially condensing, used for central station purposes, although since the introduction of the wonderfully successful and highly economical uniflow steam engine, the steam turbine has been driven back upward to 2500 kw.; but where there is any demand for exhaust steam for heating, cooking or drying purposes, the simple steam engine will maintain its supremacy and become more and more used as the great value of exhaust steam for this purpose is realized.

The best thermal efficiency claimed for a steam turbine is about 25 per cent and for an internal combustion engine about 30 per cent, whereas by using the exhaust steam from an engine for heating purposes a thermal efficiency of from 75 per cent to 90 per cent is not uncommon in practice. The theoretically perfect efficiency of a turbine, operating under extremely favorable conditions, at 200 lb. gage pressure, 200 deg. F. superheat, and 29 in. vacuum, is only 32.4 per cent so that the limit has been very closely approached and there is no possibility of the steam turbine approaching the efficiency of the "by-product" steam engine.

The foregoing statement can be more forcibly impressed by considering the steam required to convert 1 lb. of water at 32 deg. F. into steam at, say, 115 lb., absolute pressure, as follows:

1. Heat required to raise 1 lb. of water at 32 deg. F. to water at 212 deg F., B.t.u. of sensible heat 180
2. Heat required to convert 1 lb. of water at 212 deg, F. to steam at 212 deg. F., B.t.u. of latent heat 970.3
3. Heat required to raise 1 lb. of steam from 212 deg. to 338.1 deg. F., the temperature of steam at 115 lb. absolute pressure, B.t.u. of sensible heat 38.5

Total B.t.u. 1188.8

It requires the same heat from the furnace to produce 1 B.t.u. of latent heat of evaporation as it does 1 B.t.u. of sensible heat, but there is yet to be devised a method of converting this enormous quantity of latent heat into mechanical energy, and, unless this heat is used for heating, cooking, boiling or drying purposes, this energy in the steam is wasted—except where it is partly used for heating the feed water, and then only about one-seventh of it is used, as generally the feed water enters at about 70 deg. F. and is raised to about 210 deg. F.

Exhaust Steam Required for Feed-Water Heating

In a non-condensing plant, only about 1/7, or 14 per cent, of the steam exhausted from the engine and auxiliaries can be utilized for feed water heating. About 86 per cent of the exhaust steam is wasted. The feed

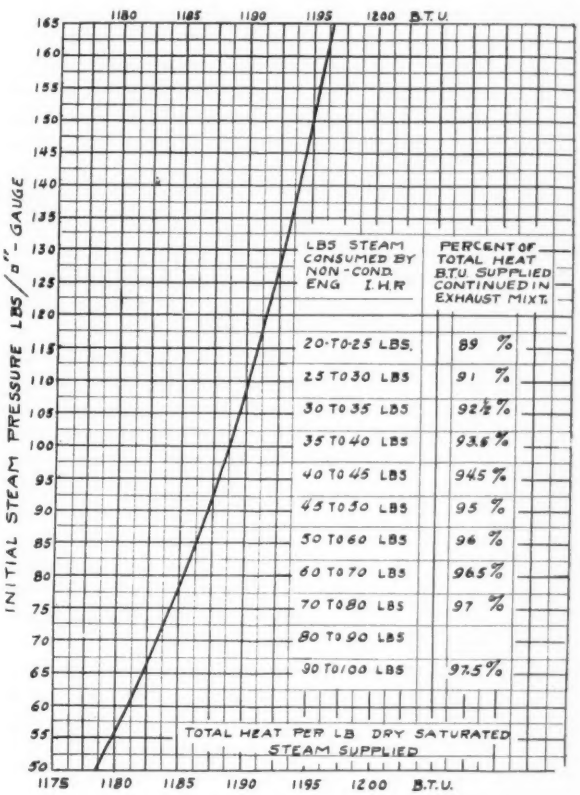

INITIAL STEAM PRESSURE LBS/□" GAUGE
TOTAL HEAT PER LB DRY SATURATED STEAM SUPPLIED
B.T.U.
LBS STEAM CONSUMED BY NON-COND. ENG I.H.P.
PERCENT OF TOTAL HEAT B.T.U. SUPPLIED CONTINUED IN EXHAUST MIXT.
20-TO-25 LBS. 89 %
25 TO 30 LBS 91 %
30 TO 35 LBS 92½ %
35 TO 40 LBS 93.6 %
40 TO 45 LBS 94.5 %
45 TO 50 LBS 95 %
50 TO 60 LBS 96 %
60 TO 70 LBS 96.5 %
70 TO 80 LBS 97 %
80 TO 90 LBS
90 TO 100 LBS 97.5 %

FIG. 1. VARIATION OF TOTAL HEAT WITH INITIAL PRESSURE OF DRY SATURATED STEAM

water should be heated to 212 deg. F. It is impossible to heat to a higher temperature (atmospheric pressure) without causing it to vaporize into steam; and, furthermore, it is a physical impossibility to heat the feed water to a temperature higher than that of the exhaust steam which is used for heating. The temperature of this exhaust steam is always, at atmospheric pressure, 212 deg. F.

The exhaust from the engine and auxiliaries is practically all steam, although it does carry some moisture. This exhaust steam holds the same amount of heat as

any steam at 212 deg. F. Now, the latent heat in this steam, the heat which each pound of steam will give up in changing from steam at 212 deg. to water at 212 deg. is, as taken from a steam table, 970.4 B.t.u.; but the heat required to raise the temperature of 1 lb. of water from 50 deg. F. (which is the average cold feed-water temperature) to 212 deg. F. is only: $212 - 50 = 162$ B.t.u. Therefore, the number of pounds of cold feed water which will be heated from 50 to 212 deg. F. by 1 lb. of exhaust steam will be $970.4 \div 162 = 6.0$ lb. One pound of steam will, then, afford all of the heat that 6 lb. of feed water can absorb under the circumstances.

Now consider the proportion of the total steam generated which is useful in feed water heating. For each 6 lb. of cold water, at 50 deg. F. as above described, which is pumped into the boiler, 1 lb. of water condensed from exhaust steam is pumped with it. (This assumes that an open feed water heater is used.) This gives a total of 7 lb. of hot feed water pumped into the boiler for each pound of exhaust steam used. Thus only about 1/7 or 14 per cent of the total water pumped into the boiler—1/7 of the steam, generated, but finally exhausted through the engine and auxiliaries—can be effected for feed water heating. The remainder or 86 per cent of the exhaust steam is wasted—unless it is employed for heating or some similar useful non-power generation purpose.

Obviously the amount of exhaust steam of such a non-condensing plant should be maintained at a minimum. Thus the auxiliaries—boiler feed pumps and the like—should be mechanically or motor driven, in which case they will be productive of much less exhaust steam than if they are direct steam driven.

In a condensing plant, only about one-eleventh or 9 per cent of the steam generated by the boiler can be used for heating the feed water. In a condensing plant, all of the steam from the engine is condensed with cold water and discharged into the hot well. Some of the auxiliaries should be operated non-condensing so that their exhaust steam can be used for heating the feed water up to 212 deg. F., if possible. The temperature of this condenser discharge water which is now used from the hot well for boiler feed is about 120 deg. F. Therefore, to raise its temperature to 212 deg. F., there will be required only $212 - 120 = 92$ B.t.u.

It is assumed that the open feed water heater will be used. Hence, for these conditions the number of pounds of feed water which will be heated from 120 deg. to 212 deg. by 1 lb. of exhaust steam (which will give up 970.4 B.t.u. of latent heat in changing from steam at 212 deg. to water at 212 deg.) will be: $970.4 \div 92 = 10.6$ lb. That is, 1 lb. of the exhaust steam will heat 10.6 lb. of feed water to 212 deg. Now with each pound of the hot-well water which is fed into the boiler, 1 lb. of condensed steam which is used in raising the temperature of the hot-well water is fed in with it. Hence, for each 1 lb. of exhaust steam utilized for feed water heating there is fed into the boiler: $10.6 + 1 = 11.6$ lb. of feed water at a temperature of 212 deg. F.

This being true, there is only $1/11.6 = 8.6$ per cent, or say 9 per cent of the total steam generated by the boiler which can be used for heating feed water. Obviously, then, the ideal economic condition for a condensing plant is to have auxiliaries which will furnish exhaust steam to an amount equivalent to about 9 per cent of the steam generated by the boiler. It should be understood, however, that the 9 per cent is the ideal value which applies only for the water temperature conditions specified for this example. But for every ordinary case the value will be somewhere around 9 per cent. Losses, such as condensation and the like, for which no allowance has been made in this problem, will tend to increase above 9 per cent, the amount of exhaust steam which can be used for feed-water heating.

It is reasonable to expect that the auxiliaries in the average plant will supply at least the amount of exhaust steam required for heating the feed water. Every effort should be made to produce just enough exhaust steam to heat the feed water up to 210 or 212 deg. F. But there should be no exhaust steam in excess of this. If there is, it will be wasted.

A practical case will further and best show the point in question. Take a simple automatic cutoff governor engine operating at 100 lb. gage pressure, 5 lb. back pressure, requiring 40 lb. of dry saturated steam per i.hp. per hour.

The thermal efficiency of this engine will be $2545 \div (1189 \times 40) = 5.3$ per cent, and there remains in the exhaust steam mixture 94.7 per cent of the total heat supplied; but all of this is not available for heating purposes, as part of the mixture contains water of condensation, amounting to 3 per cent in this case, so 97 per cent of the heat of the exhaust mixture is available as dry steam. As the total heat of steam at the exhaust pressure of 5 lb. gage is 1156 B.t.u., there is available 97 per cent of 1156, or 1121 B.t.u., per pound of steam, and this is $1121 \times 100 \div 1189$, or 94. 3 per cent of the total heat supplied.

The curve, Fig. 1, with table thereon will serve to obtain this value quickly. The total heat of steam at 100 lb. gage equals 1189, and the percentage of total available in the exhaust, corresponding to 40 lb. steam consumption per i.hp. is 94.5 per cent—which checks sufficiently close for practical purposes, and as close as the engine consumption will be known.

Again referring to the useful heat in the steam—1121 B.t.u.—if it is used for heating purposes and condensed to water at 212 deg. $1121 - 212$ or 909 B.t.u. will have been used for this purpose, or $909 \times 100 \div 1189 = 76.6$ per cent of the total heat supplied is used for heating. There is also a credit to be given for the heat returned to the boiler in the feed water, as we started with water at 32 deg. F.; this is $212 - 32 = 180$ deg., or 15.1 per cent. Summarizing the total energy extracted from the original steam supplied the engine, we have 5.3 per cent converted into mechanical energy, 76.6 per cent used for heating purposes, and 15.1 per cent returned to the boiler in feed water, or a total thermal efficiency of 97 per cent.

This does not take into consideration any pipe heat losses, which will be governed by the length and size of pipe and covering used; but it will be seen that an over-all-thermal efficiency in practice between 75 per cent and 90 per cent is not impossible, nor is it uncommon in a strictly modern and well designed plant.

It will also be noted that the power developed by the engine is nothing more than a "by-product" and the exhaust steam from it is really the useful product.

It may prove interesting to figure out the loss in tons of coal if the exhaust steam was wasted in the above

case and live steam used instead for heating, which is not infrequently the case. Say the engine is a 100-hp. using 40 lb. of steam per horsepower per hour, as in the above example, operating 10 hr. per day and 300 days per year; there will be exhausted 12,000,000 lb. of steam containing 1121 B.t.u. per lb., or a total of 13,452,000 B.t.u. If coal costing $4.00 per ton, having a calorific value of 12,500 B.t.u. per lb, is used, and a boiler efficiency of 60 per cent, a fair operating condition, each pound of coal will produce 7500 B.t.u. of steam, thereby requiring 1,800,000 lb. of coal, or 900 T., or $3600 per yr. wasted.

Should such wasteful condition be tolerated, and does it exist in your plant?

When a temperature not in excess of the exhaust steam temperature is required, exhaust steam is just as good as live steam for heating purposes, even better, as the gentle puffs of the engine exhaust seems to aid the circulation of the steam through the heating system and prevent air pockets being formed.

Heating Value of Exhaust Steam Shown by Indicator Diagrams

The accompanying indicator diagram is from a 17¼ by 36-in. engine running at 96 r.p.m., the exhaust of which is used for heating purposes. It is fair to assume

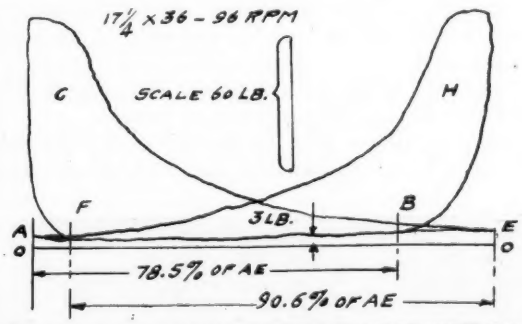


FIG. 2. INDICATOR DIAGRAM USED TO SHOW HEATING VALUE OF EXHAUST

that the exhaust steam delivered by the engine has the same heat value as an equal volume of dry saturated steam at the same pressure. The volume of steam discharged during each exhaust stroke will be equal to the piston displacement from the beginning of the return stroke to the point of stroke where the exhaust valve is closed or the point usually referred to as the beginning of compression. In card H, the beginning of the return stroke is represented at A, the point of closure of the exhaust is indicated at B, and as the distance AB is, by measurement, 78.5 per cent of the length of the diagram, the volume of exhaust discharged from the H or head-end of the cylinder is that same percentage of piston displacement for a complete return stroke represented by AE, the length of diagram. Similarly, for the crank end card, the distance EF represents 90.6 per cent of the piston displacement of the return stroke in the crank end of cylinder.

Neglecting the reduction of piston displacement in the crank end of the cylinder, due to presence of the piston rod, the displacement for a complete stroke of the piston would be $(17\frac{1}{4} \times 17\frac{1}{4} \times 0.7854 \times 36) \div 1728 = 4.87$ cu. ft., and in 96 r.p.m. for the fractions of strokes during which the piston pushes the exhaust from the cylinder, there will be delivery of $4.87 \times (0.785 + 0.906) \times 96 = 790.6$ cu. ft. of exhaust steam per minute at pressure of about 3 lb. gage as indicated above atmospheric pressure line 00.

The density of steam at 3 lb. gage is 0.045,12 lb. per cu. ft. so that the delivery would amount to $790.6 \times 0.04512 \times 60 = 2140.3$ lb. of steam per hour. The latent heat of steam at 3 lb. gage is 963.7 B.t.u. per pound and without crediting any recovery of heat from the condensate the exhaust would have a heating value of $2140.3 \times 963.7 = 2,062,607$ B.t.u. per hour. As one boiler horsepower is equivalent to 33,479 B.t.u. per hr., the exhaust would have a value of $2,062,607 \div 33,479 = 61.6$ b.hp. (To be continued)

We'll Soon Have Winter

By N. G. Near

WINTER is approaching, and now is the time to get ready for it.

Statistics show that the life of an engineer is in greater danger in the winter months than during the summer. There are many more boiler explosions in December, January and February than in other months. In fact, there are usually about as many explosions during these three months as in all the other months combined.

It would be well for the engineers to set a good example for others also—to call the attention of others to the fact that winter approaches.

Is the old furnace for heating the factory, shop, or house in good condition?

It isn't a good plan to wait until November when heat may be needed, at which time one is liable to fire up and say to oneself, "I'll fix 'er up next warm spell." Sometimes those warm spells never come, or something else happens.

This, therefore, is just a gentle hint.

A. R. Mumford has recently issued for the Bureau of Mines a report showing the economy of some old Babcock and Wilcox boilers. These boilers were fired by means of overfeed stokers, and are equipped with fuel economizer in the uptake. They supply steam to two large water pumps, one in continuous operation, the other being used only intermittently. In a period of over 100 hr., says Dr. Mumford, the results below were obtained. Seventy-five per cent stoker efficiency for boiler and stoker, while the overall efficiency of boiler stoker and economizer was 78 per cent. Eighty-eight thousand pounds of coal was fired with a calorific value of 13,900 B.t.u. per lb., and carbon showed 80.1 per cent, oxygen and nitrogen, 6.3; sulphur, 0.6; hydrogen, 4.5 per cent, while the proximate analysis gave, moisture 2.3 per cent; volatile matter, 17 per cent; fixed carbon, 72.2 per cent; ash, 8.5 per cent. Ash removed was 6700 lb., 19 per cent being carbonaceous matter and 81 per cent earthly matter. Heat absorbed by the boiler was 10,460 B.t.u .per hr. and for boiler and economizer 10,870 B.t.u. per hr., the economizer accounting for 3 per cent of the total of 78 per cent. This performance was more than that claimed for the new equipment offered the government.

Making Flour by Oil Power

At the Quality Mills, Austin, Tex., a Diesel Plant Run Systematically. By John Pierce

ROAMING DOWN along the railroad tracks trying to pass away the time until my train left this fine Texas city, I happened on the above-named flour mills, and hearing a familiar sound, I decided to see whence it came.

I finally found the source of it, and there "she blew"—a little 225 type "A" Busch-Sulzer Diesel, rocking along and telling the whole world that she was the old original "bear cat," and didn't care whether school kept or not.

The first thing that caught my eye was a fellow sitting on the standard box—to be found around all

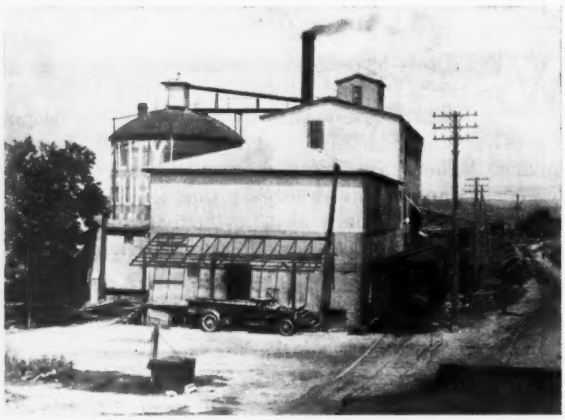


FIG. 1. QUALITY MILLS, AUSTIN, TEX.

engine rooms—with a brace in his hand and turning her slowly back and forth—there was no need to ask him what it meant—that is one of the "thorns in the side" connected with Diesel engine operation; but valves must be ground in, and that's all there is to it.

I asked him where the "chief" could be found, and he replied, "Well, I don't exactly know, but I reckon the old he goat is down there in the engine room some place."

So down I went, and sure enough, there the old "he goat" was, on another box, chewing the cud of reflection and trying to puzzle out just how quick he could do another little job some 10 ft. away and yet not have to get up from his seat.

I appreciated his situation, for having often, in the past, found myself in exactly the same position I know what it means when one is resting to have to get up and move around a little, and a fellow who knows his Diesel and applies his knowledge, sure has to hustle if he doesn't get that tired feeling caused by sitting down too much.

And I want to tell you that this fellow, whom we have till now known by the name of "old he goat," knows the Diesel, and has her eating out of his hand.

He has a type "A" 16 by 24 engine, and it has been running for 11 yr., runs yet as well as a new engine—and while it has never been overloaded to any extent it has carried practically full load most of the time.

E. C. Dyer is the name of the master mind that keeps this machine rolling, and he is a hog for knowledge, eating up everything he can get on the subject of Diesels, or any other internal combustion engine, and now is getting the bee in his bonnet of making himself an internal combustion engine in the shape of a turbine; he doesn't want it, so he says, for any particular purpose, only just to amuse himself.

His engine is located in a basement of the building at the end, and not under the mill proper, so that he has plenty of room overhead for pulling pistons and rods, with a 2-T. Yale block on a traveling crane to do it. This crane is carried on a curved "I" beam that goes outside the building, and, if necessary, can load or unload direct on the cars on which material is transported.

He has a well lighted and well ventilated engine room, some 40 by 50 ft., containing only the engine, compressor, bottles, a small 14-kw. direct-current generator, and a line shaft and clutch; he has plenty of room to move about and to entertain his friends.

The engine supplies power to the 400-bbl. mill, which runs to capacity most of the time, though for the past year it has run under capacity, and only 12 hr. a day, 6 days a week.

It is kept bright and clean, no oil or muss being found anywhere in the entire engine room.

The generator is used for the mill and office lights only, though it is contemplated some time in the future

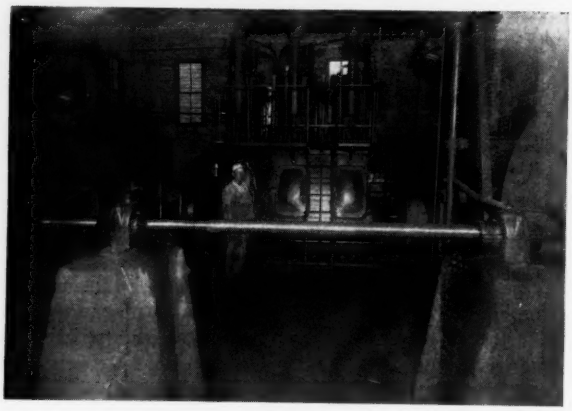


FIG. 2. INTERIOR OF DIESEL ENGINE ROOM AT QUALITY MILLS

to install a large direct-connected generator, motorize the mill, and do away with the tremendous friction loss caused by the many belts.

This engine has broken one cylinder during its life time, and many heads have been cracked—old "he goat" like all other engineers said, "Yes, she cracked a lot of them, but that was before I came on the job." So I asked him if he meant that none had gone bad on him, and told him to tell the truth, the whole truth, and nothing but the truth; that when I had been in the operating business once myself, I, too, always said it

was before my time. He admitted, with a pleasant grin on his face, that a few had gone by the board even under his own reign.

She now has two cylinders,—bushed,—which were first bored out large enough to take a good bushing, and then bushed to her original 16 in. diam., so that the same pistons could be used again. The bushings in these two cylinders are the second ones to have been installed while the third cylinder is a new one, the other having cracked some 11 mo. ago.

Rings have averaged a year's service each, before being replaced with new ones, and some of the old ones could possibly have been used for the second year, but as they are inexpensive it was thought better to use all new rings each time.

The engine is clutched to the mill shaft at a point on the jack shaft, so that the engine will have no heavy pull on starting, and as soon as she is up to speed, the clutch is thrown in.

Atomizers are cleaned every Sunday, and valves are ground in every three weeks; that is, one set is ground in one Sunday, the second set the next Sunday, and the third set the following Sunday. By doing this work systematically, Mr. Dyer has found that he can do all the grinding necessary on any one valve in 30 min., and if they need a little more than that he faces them in his lathe, which takes him some 5 min. after they are once "chucked" in the lathe.

I was pleased to have Mr. Dyer say that some few years ago he had read a couple of pages of "don'ts" and "do its" as well as some other little things written by one John Pierce for Power Plant Engineering and relating to Diesel engines, and that he had profited greatly thereby. I was almost tempted to tell him that he then beheld old John himself but I was afraid of his asking too many things about sister Diesel, and I had rather remain great though absent, than fail to answer him satisfactorily though present; so I told him nothing.

Well, I did tell him that I thought a lot of old John myself, and really believed that John knew a whole lot about Diesels that the Busch-Sulzer people themselves should know.

Looking over the table showing the results of one of the "tests" one will see that Mr. Dyer is not only operating his engine to his own satisfaction, but that he is proving to himself that she is so operating, and is doing no guessing about it.

He also attends a class at one of the colleges that is being taught, at this time, the mysteries of the internal combustion engine, and is reading everything he can get on the subject. He is an old time steam man, and at first did not like the idea of the Diesel trying to put old "Betsy" on the shelf; but, like all other wounds, his love for Betsy was only a cracked heart, and not a broken one, and so Miss Diesel has him vamped, and he will be true to her—at least until he gets his own internal combustion turbine made. Then I am afraid for his present love.

Taking example from the afore-mentioned John Pierce, Mr. Dyer makes his own needles from Tobin Bronze, and finds them cheaper, and much superior to those furnished by the factory. He finds also, that they do not batter up the seat, and require its renewal every so often, as was the case before using the bronze needles.

This engine is running at 160—164 r.p.m. and runs exceedingly quiet both with load and empty. The exhaust shows no sign of smoke, and is clear as air, though as she reaches her full load she makes a slight blue haze, hardly enough to be noticed.

Every 6 mo. the crank case is thoroughly cleaned and washed, but for a time Mr. Dyer experienced a lot of trouble with his crank case. The oil would get thick and clotty, and seem to have lost its lubricating qualities. The engine would make lots of carbon, and the exhaust would smoke badly as soon as the oil began to get thick. All kinds of oil were tried, and every oil representative in the country send his lubricating engineers to the place to study out the reasons for it; but all in vain, until one day the "old he goat" put his own head to work, and solved the puzzle. He found he could only get his injection air to 60 atmospheres, and sometimes to 65, so he overhauled his compressor, and shaped her up until he got 70 to 75 atmospheres for his injection. This stopped his oil troubles in his crank case, and he has had no more trouble from that source.

Another trouble he experienced for a long time was that the cotter keys in his wrist pins would shear off, and the nuts work loose allowing the pistons to "throw" themselves against the heads, causing a terrific pounding and, if not stopped at once, a cracked head. This he has remedied by "peening" over the ends of the pins as well as using heavier cotter keys.

RECORD OF TRI-MONTHLY TEST OF QUALITY MILLS DIESEL ENGINE PLANT

Reading	1	2	3	4	5	6	7	8
Time	2.25	2.30	2.35	2.40	2.45	2.50	2.55	3.00
Compressor Pressure lb. - 1st Stage	53	53	53	53	53	53	53	53
Compressor Pressure lb. - 2d Stage	205	205	205	203	202	203	204	202
Injection air. lb	1010	1010	1010	998	998	998	998	998
Temp. Inlet Water- deg.	97	97	98	99	100	100.5	101	101
Temp. Outlet Water- deg.	113	114.8	114.8	114.8	114.8	116.6	116.6	116.6
Temp.Air Intake - deg	105.8	109.4	107.6	107.6	109.4	107.4	104	107.6
Exhaust Temp. - deg.	787	752	752	752	752	787	752	752
Gal. Water per min.	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8
Fuel lb. per b.h.p.hr.	.616	.616	.578	.705	.621	.621	.705	.621
R.P.M.	164	164	162	161	161	161	162	161
I.H.P.	153.9	153.9	153.9	164	142.7	1F6	153.4	153
B.H.P.	108.9	108.9	108.9	119	97.7	111	108.4	108
Mech. Effcy. Per cent	70.8	70.8	70.8	72.6	68.5	71.2	70.7	70
Per cent rated load	48.4	48.4	48.4	52.9	43.5	49.4	48.2	48.0

After 9 yr. constant running, this engine was gone over by Mr. Dyer for levels, and the flywheel end of the crankshaft was found to be 1/64 in. low, which, considering the length of constant service, is to be considered something wonderful; at least the writer thinks so.

This engine is timed every 3 mo., and while the same cams and cam shafts are in her that came, they are still in first class shape, and the same noses are on her that came from the factory in place. Fuel is given a lead of 2½ in. on the flywheel, and Mr. Dyer is very particular to see that she is kept at just that.

Fuel used is the so-called "gas oil" of 32 to 34 gravity, and costs about four cents per gallon laid down at the mill.

One thing that did not have Uncle John's approval, and I found it did not have anybody else's either, was

that the cooling system was used backwards, but there is no help for it,—not till the owners wake up to the fact that what their engineer is telling them is right, and they will some day have to pay for a few new heads or cylinders on account of it. The tank which is used for cooling water is a 50-bbl. tank, sets at the side of the engine room, and has but 3 ft. head. This having been found to be insufficient, the engineer wanted to raise it, but was over-ruled, so she still "sets" there, and the water runs from the bottom of it direct to the little cooling pond outside, the pump taking water by suction from this cooling pond, and forcing it up through the cylinder jackets, and into the tank. Some day the little old centrifugal pump will get a little air, lose her priming, and the next thing will be a few cracked cylinders or heads; then what? Why then the engineer will catch hell, of course. I have had this very thing happen to me, and I know the causes of its happening, and what is said to the engineer after it does happen.

Some day, let us hope, when men hire engineers and make them responsible for their plants, they will give up the idea of trying to run the engine from the office, and will let the engineer run such things according to his training. For if he is to be responsible for the welfare of the plant, he should be granted authority to make any change that tends toward the betterment of the plant.

Sometimes, of course, the engineer is wrong, and if too much is left to him, ruination follows in his footsteps. In connection with this I want to jump over to another plant less than two city blocks from the Quality Mills, and tell you what I saw there, and what I was told about it by a number of different people,—and they were not engineers who might have been talking through the everlasting grudge and prejudice that every engineer seems to feel for his brother at arms.

I went into a place that has not turned a wheel for almost 2 yr., and found a couple of Diesels sitting there, with their heads hanging down as if they were too embarrassed to look one in the face again; poor old mistreated sisters, hammered on the back as long as they could stand up under it, and then left to die. Dog-gone it, I can't help but feel that an engine is as much human as any living person, and that they should be treated in a humane manner; and those two old ladies sitting there made me want to cry.

The tale, as it was told to me, runs as follows: A company installed these engines and started in. The engines did good work, and ran fine, but the company that made the engines had said that "anybody" could operate its engines, and that no special trained engineer would be needed. Well this new company believed it, and got a first class steam engineer to run those engines. This man was a cracker-jack good steam man, but was one of the old school that could not believe an engine was an engine unless she used coal and niggers to fire and had a little soot blowing around most of the time from blowing flues; so he never did take any great interest in the operation of the engines, which, naturally, went from bad to worse, so that the upkeep on them was something terrible. The matter went on till it was a case of rebore and rebuild, and the company could not afford to do it, nor could they afford to install steam engines as their engineer suggested. Finally the old lady Diesels said they wouldn't eat any more beans until their digestive organs were patched up. As a result, the company went out of business,—bankrupt,—and a dozen business men told me that it can all be traced to lack of service in the power plant. Upon asking why matters were not remedied by getting a different engineer, I was told that this man had had a wonderful record as a steam man and, of course, nobody ever imagined that it took a specially trained man to run a Diesel, especially after the Diesel people themselves had said so. The moral of the tale is, that, if this man had had the energy and ambition to prove the Diesel a good engine, instead of cussing the old girls, and letting them go to pieces because of his prejudice, then this company would today not have been on the rocks, but would now be a going concern.

Interesting Oil Engine Economy

In a recent letter from the Western States Portland Cement Co. at Independence, Kan., A. D. Stancliff, superintendent, states that they are using two McIntosh & Seymour oil engines together with two steam units to operate the mill. One oil engine is 6 cylinder, 1000 hp., the other 4 cylinder, 500 hp., both being direct connected to a.c. generators delivering 3-phase currents at 600 v. and 25 cycles.

Records over a long period show that the engines use 0.7 lb. of fuel oil per kw.-hr., and the cost of operating and repair supplies averaged for a year 0.12 c. per kw.-hr.

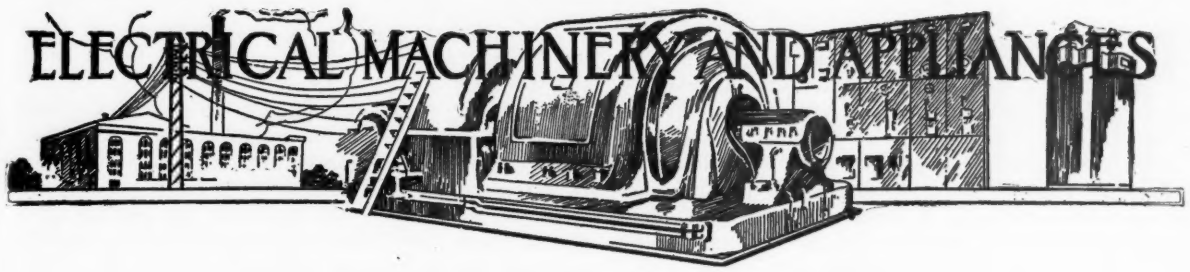
All previous records for monthly production of gasoline in the United States were broken in July, when 569,711,415 gal. were produced, according to figures compiled by the United States Bureau of Mines. The July output of gasoline represents an increase of 44,000,000 gal. over the June production and 56,000,000 gal. above the figures for May. The increase over July of last year is 150,000,000 gal.

Domestic consumption of gasoline for July was also the largest ever recorded in a single month, amounting to 566,000,000 gal. as compared with 507,000,000 gal. for June and 457,000,000 gal for July of last year. The fact that consumption figures showed a larger increase than the production figures accounts for a reduction of stocks of gasoline for the month, amounting to 52,000,000 gal. Thus stocks on hand Aug. 1 were 722,908,949 gal., or 6.31 per cent less than the figures for July 1, which aggregated 824,966,456 gal.

When we see or hear of the destruction caused by certain birds and insects we often feel that we have a right to question the good that they are said to do, but how many of the effects of nature are we fully acquainted with?

Do you use shellac? Ever think of its origin?

In the East Indies there is a small insect that feeds on the sap of certain trees. Were you to see myriads of these little creepers on the trees you would be ready to say, "Good night, tree," but guess again. The little insects are chemists at work and when they exude the sap which they obtained from the tree, it forms a tiny cocoon. The cocoon when boiled gives us shellac and shellac is indispensable to the manufacturing world.



Polyphase Wattmeter Connections---I

NECESSITY FOR ACCURACY IN METERS; INSTRUMENT TRANSFORMERS AND THEIR USE IN CONNECTION WITH WATTMETERS. BY L. P. STAUBITZ

IN MANY industrial plants where large amounts of electric power are used, too little attention is given to the meters and too much reliance is placed upon their readings, without definite knowledge of their accuracy. The importance of accurate meter readings must not be underestimated, especially when it comes to the matter of figuring costs, for, of what use are fancy figures on efficiency, power charges, etc., if the meter is at fault? In many cases, there is no way of checking the feeder meters as the subdivisions may not have meters.

It is the purpose of this article to discuss the operation of watthour meters and some of the various connections that are possible with different types of wattmeters and integrating watthour meters.

Many of the errors of meters are due to the improper connection of the meter rather than to any inherent error of the meter itself. Too often the meter is blamed

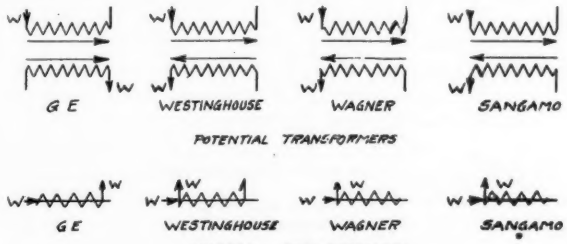


FIG. 1. DIAGRAMS SHOWING POLARITY MARKINGS OF VARIOUS MAKES OF INSTRUMENT TRANSFORMERS

for inaccuracy, but it can be said that it is rarely that a recording wattmeter is received from the manufacturer improperly connected internally.

The wattmeter of today is delicately constructed and when properly connected is an accurate and trustworthy instrument. For a wattmeter to register correctly, it is necessary to have the proper phase relation between the voltage on the pressure element and the current in the corresponding current element of the meter. It is also necessary to have the proper phase voltage and current on the meter elements in the proper sequence.

An attempt will be made to eliminate as far as possible any theoretical considerations, diagrams and illustrations being used as far as possible; however, it will be necessary to resort to some theoretical discussion in order to describe the functioning of the meter.

For small loads, the wattmeter may be installed directly in the lead; but for heavy loads and high voltage, it is necessary to operate the wattmeter from so-called instrument transformers. A thorough understanding of the current and potential transformer is

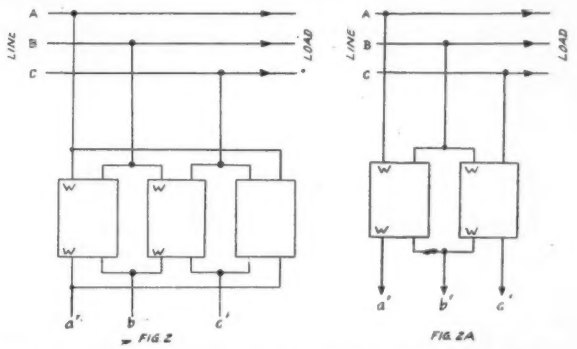


FIG. 2. SHOWING METHOD OF CONNECTING THREE POTENTIAL TRANSFORMERS IN DELTA

FIG. 2A. POTENTIAL TRANSFORMERS CONNECTED IN OPEN DELTA

therefore essential to the successful consideration of the wattmeter operated from these instrument transformers.

POTENTIAL AND CURRENT TRANSFORMERS

THE POTENTIAL transformer is used to reduce the voltage of the line to a safe voltage, usually 110 v. for use on the meter pressure coils. The potential transformer has no unusual characteristics other than those of any transformer except that it is more carefully designed for phase angle. A potential transformer should never be "shorted." The number of meters supplied from potential transformers should be limited to the transformer rating which is in watts.

A current transformer is used to transform the heavy line currents to the usual 5 amp. used in the meter circuit. The functioning of the current transformer is unusual. The current flowing in the primary of the usual power transformer or potential transformer is due to the current flowing in the secondary. With no current in the secondary there will be only the exciting current in the primary. The current transformer primary current, however, is governed by the load flowing in the line. The current in the secondary is dependent on that of the primary and bears a direct ratio to it. The impedance of the primary of a potential transformer is high while that of the current transformer is compara-

tively low, thus offering little opposition to the flow of line current through its primary winding. The secondary circuit of a current transformer should never be opened while there is load current flowing in the primary circuit. No damage can be done by short-circuiting the secondary terminals of a current transformer, as the secondary current will bypass through the short circuit without increasing in value. The danger in opening the secondary of a current transformer lies in the fact that dangerously high voltages are generated in the secondary winding. At the interruption of the flow of secondary current, the flux in the iron core does not have a counterflux from the secondary winding and although the number of turns in the secondary is small, the flux is very high and the generated voltage is dangerous. If the body should then form a closed circuit to this winding, a very severe shock would result.

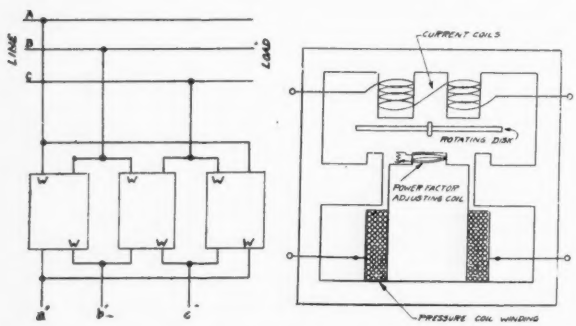


FIG. 3. POTENTIAL TRANSFORMERS CONNECTED IN DELTA
FIG. 4. ARRANGEMENT OF CURRENT AND PRESSURE COILS OF ONE ELEMENT OF POLYPHASE WATTHOUR METER

There is also the probability of breaking down the insulation of the secondary winding due to these voltages, causing improper operation of the current transformer.

Most current transformers are designed to give 5 amp. in the secondary with full load in the primary circuit. This greatly assists in the design of the meter, as it can be constructed to operate on low voltage and small currents. The meter can thus be used on any of the current transformers having different primary ratings by properly correcting the constant of the meter.

Polarity

THE REMAINING characteristic which is common to both the current and potential transformer is polarity. By polarity we mean the direction of flow of current in one winding to the direction of flow of current in the other winding at the same instant. The manufacturers of instrument transformers have adopted a standard of polarity and all instrument transformers of their make are so marked. The marks always indicate that when the current is flowing into the marked primary lead, it is flowing out of the marked secondary lead. This marking may be by brass tag, paint, or if the instrument transformer is mounted on a base, by a metal tag mounted on this base. Sometimes the physical relationship of the primary and secondary is all that is needed. In referring to primary and secondary, it is considered that the primary of the potential transformers is the high voltage side and the primary of the current transformer is the heavy current winding. The thorough understanding of the meaning of polarity is essential to the proper connecting of the instrument transformers and their meters.

The polarity of the instrument transformers of a number of the manufacturers is shown in Fig. 1 and illustrates the methods of representing a current transformer (C.T.) and potential transformer (P.T.) in a diagram. It is seen from Fig. 1 that there are two general types of instrument transformers; those in which the polarity markings are on the same side and those in which they are on opposite sides. This statement is true only when the physical location of terminals is as shown. Assuming the windings to be as shown, there is this difference in the two types, namely, in one type the current in the primary and secondary have instantaneous flow in the same direction, while in the other type the two are in the opposite direction.

The fact that the current transformers have polarity markings makes it necessary to consider the flow of current through them when making meter connections and diagrams.

Influence of Polarity on Connections

WE CAN NOW consider the influence that polarity has on the connecting of the potential transformers in a bank to supply a wattmeter. In considering the flow of power current in a three-phase line, we may take it at the instant that it flows from A to B, B to C, and C to A, thus completing the cycle. The connection shown in Fig. 2 consists of three potential transformers connected in delta from a three-phase system, the secondary voltage being 110 v.

The polarities shown on each individual transformer are those shown by the manufacturer. Consider the flow of power current for one instant from A to B phase.

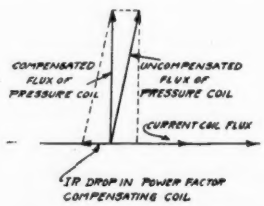

COMPENSATED FLUX OF PRESSURE COIL
UNCOMPENSATED FLUX OF PRESSURE COIL
CURRENT COIL FLUX
IR DROP IN POWER FACTOR COMPENSATING COIL

FIG. 5. DIAGRAM SHOWING RELATION OF FLUX OF POTENTIAL AND CURRENT COILS AT UNITY POWER FACTOR

The primary current of the left-hand potential transformer enters the high voltage winding through the lead with the white polarity marking (W) and at the same instant the secondary current is passing out through the white marked secondary wire. Continuing in the same manner with the flow from B to C, the secondary current flows out of the left-hand lead of the middle transformer and for a flow from C to A phase, the secondary current flows out of the left-hand lead of the third transformer of Fig. 2. In Fig. 2-A is shown the same type of potential transformer, but connected in open delta.

Figure 3 shows three potential transformers of the other type connected in delta. In following through the same method as above, we find that in each case the primary current enters through the left-hand lead and flows out over the right-hand secondary lead. It will be noted that the secondary leads have the same lettering

as those in Fig. 2. This is done to aid in identifying the leads and later on it will be shown how this is compensated for with this type of potential transformer when connecting up a wattmeter.

Wattmeters

Part of the misunderstanding that exists about induction wattmeters is due to the confusing of the relationship of pressure and current that exists external to the meter and that of the flux produced by the potential and current coils of the meter.

In order to produce motion in the disk of the wattmeter we must have two magnetic fields that are out of phase with each other and rotate. The reaction between these two fluxes will produce rotation of the disk. If, however, the two fluxes have the same time phase, no rotation of the disk will result. Consider a single-phase meter.

At unity power factor the flux from the potential coil and current coil would be in phase and no reaction would take place, thus no rotation. It is desired to have the disk rotate at maximum speed at unity power factor to meter the load properly. It is therefore necessary to have the maximum phase displacement between the potential coil and current coil flux occur at this time.

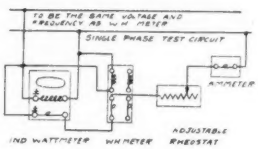


Fig. 6. Method of testing polarity of a watthour meter

This is accomplished by the insertion of reactance in the pressure coil circuit. In some indicating meters this reactance is external to the meter, but with watthour meters the pressure coil is wound directly on an iron core which makes it inductive as shown in Fig. 4.

Due to the presence of the resistance of the wire of the pressure winding, the angle produced by the inductance is not exactly 90 deg. Compensation for this is obtained by the winding of a few turns of wire on the pressure coil iron core, and short-circuiting this winding through an adjustable resistance. This resistance is adjusted until the potential coil and current coil flux are at exactly 90 deg. at unity power factor load. This assures accurate registration on all power factors. This adjustment is shown in Fig. 5. The existing conditions, therefore, are that when the pressure and current at the terminals of the meter are in phase (unity power factor) the flux of the pressure and current coils are at 90 deg. to each other and maximum rotation of the disk is obtained.

At zero power factor the pressure and current at the terminals of the meter are at 90 deg. to each other and the flux of the pressure and current coil are in phase and there is no rotation of the disk.

Polyphase wattmeters are simply two complete single-phase meters having their disks connected by a shaft which operates the dial mechanism.

There are many types of wattmeters in respect to the method of bringing the internals to the external posts. The method of connecting the coils to the binding posts determines the polarity of the meter. It is necessary to know the instantaneous flow through the coils to give the correct rotation of the disk. If this information cannot be obtained from the meter diagram it will be necessary to determine this experimentally. This may be done by the use of a single-phase indicating wattmeter and suitable rheostat. The polarity of the indicating meter is usually indicated on the binding posts. The indicating meter should first be connected as shown in Fig. 6 with the meter indicating correctly. The current should be limited to not over 5 amp. by the rheostat. The W.H. meter should then have its coil connected in series with that of the indicating meter, and its pressure coil in parallel. It is only necessary to use one element of the W.H. meter. The connections of the pressure coil of the W.H. meter should be changed until the disk rotates in the correct direction. The direction of flow through the coils necessary to give correct rotation is the same as that of the indicating meter.

The foregoing remarks were mainly for the purpose of acquainting the reader with some of the fundamentals involved in connection with the details of polyphase wattmeter connections. In a subsequent article, the author will discuss the various methods of connecting polyphase meters and some of the more important pitfalls to avoid.

Selection of Polyphase Motors

A Brief Discussion of the Principal Characteristics of the Three General Types of A. C. Motors. By William S. Jones

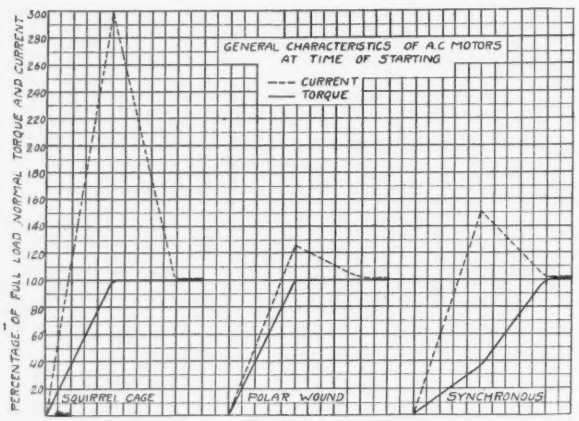
There are three general types of alternating current, polyphase motors,—the squirrel cage induction type, the polar wound or slip ring induction type, and the synchronous type. Each type has its advantages and its limitations. It is the object of this article briefly to point out which one of the three types is best suited to the various applications.

All of the types mentioned are primarily constant speed machines having characteristics approaching those of the direct current shunt wound motor; but the polar wound motor, if equipped with a high resistance rotor winding so as to obtain a large percentage of slip, becomes somewhat unstable in operation and its characteristics tend to be similar to an over-compounded direct current motor. The polar wound motor is, therefore, used for varying speed duty such as may be required for hoists, elevators, for compressors and reciprocating pumps. It is not, however, satisfactory for adjustable speed tool work.

The principal advantages of the polar wound motor are its low starting current and high torque. These advantages should form the basis for its selection in any given case. A machine of this type will develop full load torque, at starting, with resistance connected in the rotor circuit, without exceeding 125 per cent full load current. Wound rotor motors are therefore considered the only polyphase alternating current machines suitable where starting conditions of the load are severe or where continuous operation with frequent starting is required.

The squirrel cage motor due to its simple construction will, unquestionably, give better operating service, within its limitation, than any other motor in use today.

The absence of any moving contact parts makes it especially desirable for use in damp, dusty or hazardous locations, and its ability to withstand abuse is sometimes hard to explain. This type of motor, with reduced voltage applied at starting, requires from 300 to 500 per cent of full load current to develop full load torque and during the time of starting has a very low power-factor.



CURVES SHOWING THE GENERAL CHARACTERISTICS OF THE THREE TYPES OF ALTERNATING CURRENT MOTORS

Because of this condition, the squirrel cage motor should not be used in connection with generating plants when the motor required is of such size that its starting current exceeds 25 per cent of the generator full rated current output. Squirrel cage motors are used to advantage for crushers, grinders, mills in general, centrifugal pumps, machines equipped with flywheels, and for elevators and hoists where the operation consists principally of starting and accelerating heavy loads with intermittent short runs. These motors are manufactured with from 2 to 20 per cent slip; the greater slip being used for these latter applications.

The synchronous motor is the most desirable from the central station load standpoint because it may be operated at unity power-factor or to develop leading current which will compensate for the low power-factor of loads elsewhere on the system. This motor has a low starting torque and as a rule requires attendance. At full load input it will develop, at starting, approximately 20 per cent of full load torque. Its maximum starting torque is around 35 per cent with 150 per cent of normal input.

The synchronous motor should be used for applications requiring 100 hp. and over in which the load is fairly constant and is not fully applied until full speed of operation is attained. For motor generator sets and rotary loads, in which the starting and accelerating torque requirements come within the above limits, this type of motor should be selected. When the proposition of selling electric power by the unit of kv.a., instead of kw., becomes a general practice among central station companies, the use of the synchronous motor will increase.

The general characteristics of the three types of motors are roughly shown in the accompanying curves. These curves indicate the starting current and corresponding torque under favorable conditions of operation.

Pointers on Purchasing Lubricants

DO YOU BUY OIL WITH A DESIRE TO SECURE GOOD SERVICE OR DO YOU BUY IT WITH THE IDEA OF GETTING IT AT THE LOWEST POSSIBLE PRICE? BY THOMAS A. BROWN

THE LUBRICATION question in power plants is a much discussed subject. The discussion usually runs to, "Hello, Jack, how are you today? Fine day," etc., etc. "By the way, Jack, you use oil on your engines, don't you?"

"Oh. yes."

"Well, we have good oil at a rock bottom price, can't we get an order for a few barrels?"

And because Bill the salesman has shown himself to be a good fellow, Jack answers, "Sure, we'll give you an order, what kind of oil ya' got?"

Bill says, "Pink Oil, Blue Oil, Green Oil; what kind do you like?"

Jack says, "I always liked Pink Oil, send me up a couple of barrels."

Do you think the foregoing on exaggeration? Actually, it may be and yet in many instances the general line of conversation that occurs between the purchaser in the power house and the oil salesman is similar in principle to the above.

The question of oil purchases should be handled by an engineer or a man who has an understanding of engineering principles, because these principles govern the selection of the kind of oil and the recommendation of the correct lubricant best suited to the operating conditions.

Oil purchases can be handled from two viewpoints, namely:

First—With the desire to secure the very highest type of service possible to secure.

Second—With the one thought of price per gallon uppermost in mind. Buying anything called "lubricating oil" at the lowest price possible, and with no thought as to the real service results obtained—in other words is the purchase of lubricants handled in the same way as lumber, steel, cement, or any other commodity?

The man having the first viewpoint will give earnest consideration to the three engineering principles:

First—The possibility of reducing his friction load on the mill by the use of oils of the highest type. Under this same head he will give first consideration to the oil company that shows him they understand the types, construction, operation and lubrication of machinery. This latter fact will assure him of the recommendation of the right kind of oil from the list of oils all of which oils are those having friction reducing qualities. For let it be known that lubrication engineering comprises a full knowledge of all the above facts, or briefly "the right oil in the right place."

Second—The man having the first viewpoint will consider his cost of maintenance and repair to his machinery in so far as it is influenced by the kind of

lubricant used. In a small way this is tied up with the question of friction reduction but not entirely. A bearing journal or gear tooth may not show exceptional wear and yet there may be real opportunities to reduce the friction load on these same parts. In other words, satisfactory (so-called) operation of machinery is no indication that the machine or machinery is running with the smallest co-efficient of friction.

Third—The man having the first viewpoint will consider the question of the production of the mill. Can it be increased by the use of a correct lubricant?

Preposterous you say at the first glance; but consider, does speed have its influence on production? Does the quality of lubrication affect speed? Is production ever interrupted by hot and burned out bearings, broken down machinery, or replacement of worn parts? All these reduce production.

Does uniformity of speed play a part in building up production? A lack of uniform speed will certainly decrease production. Consideration of any one of these three factors will be well repaid when the subject of lubrication and the selection of lubricants is being decided.

Against these three very important factors, what has the man to consider who has the second viewpoint, namely, "the cost per gallon of the lubricant," with no regard for results other than to "keep her running?" This man is playing with an exceedingly small item, as compared with the three considered by the first mentioned man. This latter man is giving consideration to a cost which is insignificant as compared with any one of the other three. A liberal estimate of the latter item would be one-half of 1 per cent of any of the former items.

For you Mr. Dubious, permit me to show you the accompanying chart of what was accomplished in the way of a reduction in indicated horsepower, the only influencing factor changed was the kind of lubricant used. The case cited is one out of a total of 111.

This is one example of many, all of which run along the same lines. A horsepower year costs between $75 and $100 which in this case means a total net saving of between $1390 and $1850. This owner was amply rewarded by his giving consideration to engineering principles as applied to lubrication.

How were such results accomplished?

Solely by the introduction and use of lubricants that permitted the machinery to operate with the least amount of friction at all bearings.

Buying Oil on Specifications

In discussing the purchasing of lubricants, we must not forget the buyer who purchases his oils on specifications. Although he is rarely met with, he exists.

Those who have tried this method out have soon discovered that there is no specification covering quality. Specifications can cover physical characteristics such as are used in the refinery to check uniformity of product, but the friction reducing qualities of one oil as compared with another cannot be found except by comparison under actual operating conditions.

Oil manufacturers know that certain refinery methods, coupled with a careful selection of the crude oil will produce a lubricant that has the greatest friction reducing qualities. There is, however, a commercial factor involved with the refinery methods used. In one case a high percentage of yield of burning oils is desired in which case there is no selection or grading of crudes and the lubricants obtained later, that is after taking off the lighter fractions, are a by-product.

In the other case the sole idea of the manufacturer is to secure the highest possible quality in the lubricant, and no attention is paid to securing a high yield of burning oils, which come off in the natural way and in addition to this the crudes are carefully selected and graded. With the latter case it is a known fact that such lubricants produce the lowest possible co-efficient of friction.

Mr. Engineer, these are facts which can be substantiated by an investigation. They are well worthy your while to investigate, as the returns on your mill will more than pay you. This question of oil quality is an all important one today, and one that vitally concerns you.

A few words with respect to application of lubricants to machinery. Correct application is also a part of the lubrication engineer's work, and only by an extensive knowledge and actual experience in following lubrication does he find out the right way to apply the oil.

	A Oil Co.	B Oil Co.	Difference
Average Kw. hr. Demand per lb.	0.0512	0.0434	0.0078
Average Production per Kw. hr.	19.5	23.0	3.5
Average Feet per Kw. Input	165.0	174.0	9.0
Average Kw. hr. Demand per Hr.	164.9	148.1	16.8
Average Production per hr.	3221.0	3413.0	192.0

Total hours of operation during B Oil Co. period is 494.

Net Kw. hour saving during this period was

$$494 \times 16.8 = 7299$$

$16.8 \times 24 \times 300 = 120{,}900$ Kw. hr. saving per year.

$\frac{16.8}{164.9} = 10.2$ percent saving in power demand.

CHART SHOWING THE COMPARATIVE EFFECTS ON PRODUCTION AND THE SAVINGS EFFECTED BY THE USE OF ONE OIL OVER ANOTHER

There are three benefits derived from correct application.

First and foremost is the positive feed of oil to the bearing, thereby keeping an unbroken oil film on the bearings which in turn gives low losses in friction, and prevents wear.

Second with automatic devices installed it is possible to reduce the labor cost of oiling. Such cost cannot be entirely eliminated, however, as even with the best type of devices some attention in the way of inspection and filling is necessary. It is possible to reduce such cost however.

Third and a very minor item correct application saves the oil itself.

With such facts and when I say facts I mean facts, before you can you afford to neglect the lubrication of your machinery? Not if you are a real executive and alive to the benefits that may accrue to equal or better quality.

When adding water to the electrolyte in storage batteries, always add the water just before charging, not during or immediately after charge. The gravity of the electrolyte should not be allowed to fall below 1.200.

A Municipally Owned Lighting and Pumping Plant

Power Company's Failure to Provide Improvements Leads Municipality to Build Own Plant. By W. C. Looney

KANSAS CITY, Kansas, is the home of a successfully operated combined water pumping station and electrical power plant, one of the few such combination plants in operation in the United States.

The combination plant was not the result of any desire on the part of the municipality or the officials to engage in central station service, but was necessitated by circumstances which the citizens of Kansas City, Kansas, sought to remedy.

In 1909 the City of Kansas City, Kansas, was supplied with electrical power by a local public service company. At that time the city asked for certain improvements in its service from the light and power company and also for a revision of the then existing rates. The request was practically ignored by the power company, with the result that a bond election was held in 1910 at which the proposition of extending the municipally-owned water plant and making it a combination pumping station and electrical power plant was carried by a large majority.

This initial installation at the municipal water works consisted of a 1000-kw. and 500-kw. turbine generator unit, a switchboard to control the generators, motor driven exciters, and out-going feeders. The steam for the turbines was obtained from the same boilers which supplied the water works pumps.

The plant is located on the Missouri river 3 mi. north of the City Hall at a point called Quindaro Station. The load has grown rapidly and the plant is now one of the largest municipally-owned electric generating plants in the country. Frequent extensions have been made to accommodate this load, until the generating capacity now totals 26,250 kv.a., and the plant has assumed the dignity and title of the Quindaro Generating Station.

There are five units, one 1252-kv.a., two 3125-kv.a., one 6250-kv.a. and one 12,500-kv.a., the 500-kw. having been replaced by one of the 3125-kv.a. units. The first four named were first installed and are Allis-Chalmers units and condensers, and the last named is a Westinghouse unit and condenser. Bonds were voted for the last unit in June, 1919, and on November 10, 1919, the unit was put in service, carrying the regular load of the plant. The peak load at present is 10,000 kw. with a load factor of 60 per cent, and the total kilowatt-hours are four million per month.

Excitation is provided by two separate exciters, one motor, the other turbine driven, both 125-v. and located one at either end of the building. The turbines are provided with surface condensers, with individual air and condensate pumps.

No Condenser Circulating Pumps Required

One of the unique features of the plant is that no condenser circulating pumps are required. The condensers are located between the water works intake pumps and settling basins, so that a continuous supply of cooling water is available. They are two-pass with reverse flow connections to accomplish cleaning. Motor operated valves enable a reversal of the circulating water through the condensers without affecting the operation of the turbine. Valve motor controls are located on the operating float adjacent to the turbine served.

The generators are all three-phase, 60-cycle, 2400-v., and the turbines are built for 175 lb. gage pressure with 100 deg. superheat and 28 in. vacuum.

The turbines are equipped with the usual instrument boards with indicating instruments directly in front of the operator when at the throttle. In addition, an auxiliary board is provided for each unit for mounting steam flow meter, mercury column, barometer and recording gages for steam pressure at boiler and at throttle, steam temperature, vacuum, inlet and outlet circulating water temperatures, and condensate temperature. For the control of the electrical end, there is a 20-panel, 90-in. upright board of Westinghouse manufacture.

All generator and feeder oil circuit breakers are electrically operated. A double bus system is used and the busses and breakers are installed in a separate compartment below the operating floor. All feeders leave the building through a tunnel, approximately 100 ft. long, to the transformer house, where suitable outlets and protective apparatus are provided. Automatic induction feeder voltage regulators are located in this transformer house. Since this station is located a considerable distance from its load, two of the feeders carrying heavy industrial load are stepped up to 6600 v. by banks of three single-phase transformers rated 1000 kv.a. self cooled and 1800 kv.a. water cooled. The transformers are arranged for and lines insulated for a change to 13,200 v. at some future time.

The boiler capacity for both electric and water plants consists of five double Murray, five double Heine, and four double Babcock & Wilcox water tube boilers, provided with individual steam flow meters, gages and necessary fittings.

Stokers are installed under all boilers, the Murray and Heine having Jones old type piston operated, two of the Babcock & Wilcox have Westinghouse underfeed, and the other two Babcock & Wilcox underfeed. All stokers are steam operated. The boiler room operating floor is on the same level as the turbine floor. Suitable apparatus for obtaining and recording the general performance of the boiler plant is installed. This includes pyrometers, flue gas analysis and temperature measuring apparatus. Forced draft is used for the Babcock & Wilcox boilers, the fan being geared turbine driven. These boilers also have superheaters.

Three boiler feed pumps are installed, two reciprocating steam driven and one steam turbine driven. A high pressure Blake & Knowles feed water heater is used and provision is made to measure total amount of boiler feed. Steam for heating the boiler feed water to 200 deg. F. is obtained from the turbines driving exciter, forced draft fan and boiler feed pump. An additional forced draft fan and boiler feed pump, both turbine driven, are on order. Coal of approximately 11,000 B.t.u. is obtained from southwestern Kansas

The Kansas City, Kansas Municipal Plant

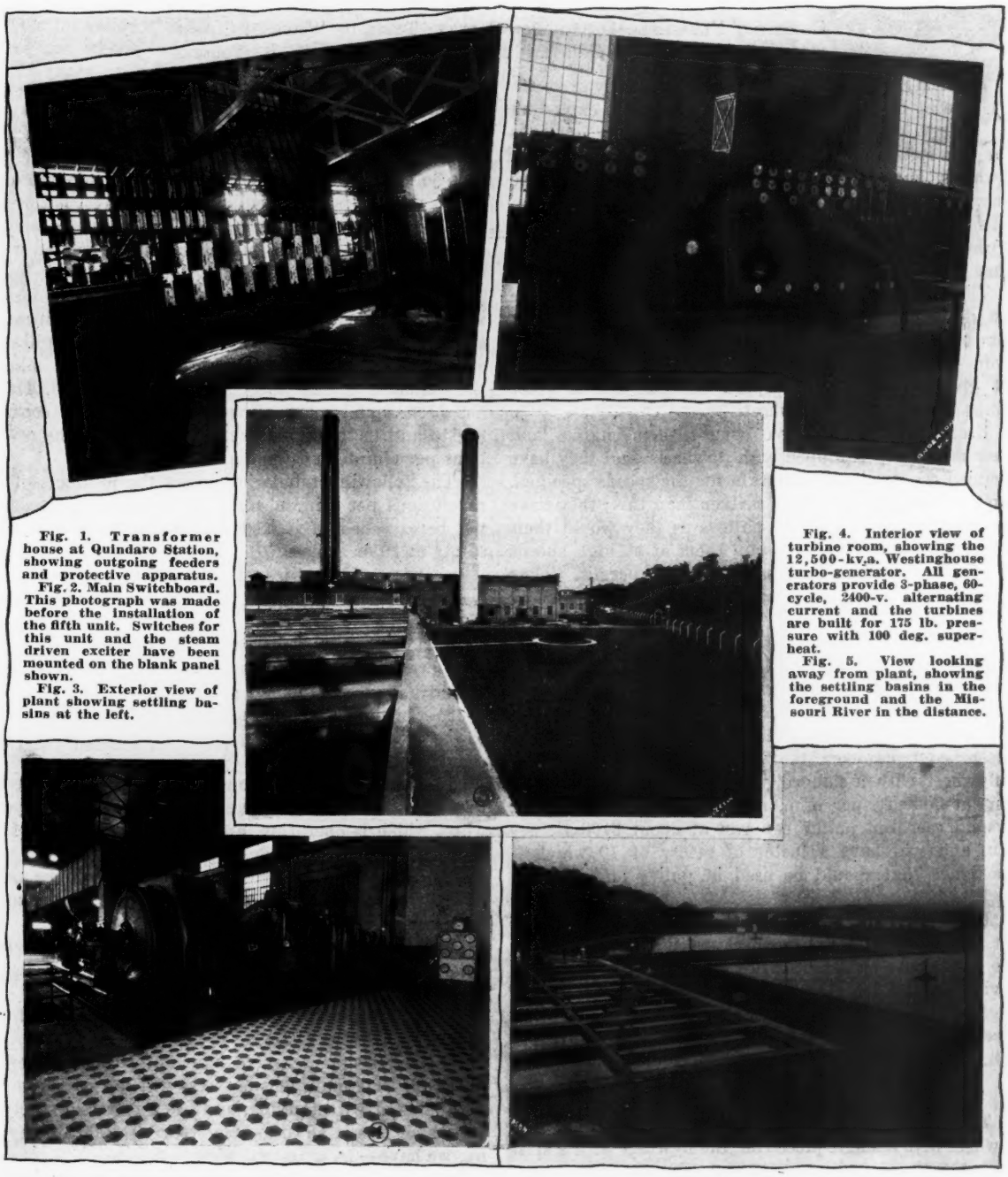


Fig. 1. Transformer house at Quindaro Station, showing outgoing feeders and protective apparatus.

Fig. 2. Main Switchboard. This photograph was made before the installation of the fifth unit. Switches for this unit and the steam driven exciter have been mounted on the blank panel shown.

Fig. 3. Exterior view of plant showing settling basins at the left.

Fig. 4. Interior view of turbine room, showing the 12,500-kv.a. Westinghouse turbo-generator. All generators provide 3-phase, 60-cycle, 2400-v. alternating current and the turbines are built for 175 lb. pressure with 100 deg. superheat.

Fig. 5. View looking away from plant, showing the settling basins in the foreground and the Missouri River in the distance.

and Oklahoma. Deliveries are made on siding at the plant by any railroad coming into the city. Hopper cars are dumped into a concrete receiver and belt and bucket conveyors take the coal to the bins above the boilers. Other cars are unloaded onto conveyor with clam-shell bucket and locomotive crane. All coal is weighed before going to the stokers. Storage is provided for 30 days' supply. The ashes are dumped onto bucket conveyors and transferred to railroad cars for removal.

The operation of the water and light plants, as well as all other matters pertaining to them are handled by the water and light department of the city organization. L. H. Chapman is commissioner of this department and J. D. Donovan is superintendent and chief engineer. To these two leaders the remarkable success of this property is attributable. Mr. Chapman has built up a complete organization of competent, loyal, and enthusiastic assistants not excelled by many private corporations in the country. He has withstood successfully the investigations and attacks of political enemies through several city administrations.

Flywheel Explosions and Their Prevention

CHECKING FLYWHEEL DESIGN FOR SAFETY; TYPES OF WHEELS; CLASSIFICATION OF CAUSES OF FAILURES AND REMEDIES. BY E. B. TOLSTED

STATEMENTS have been made frequently that exploding flywheels cause more damage than exploding boilers; whether or not this statement is a fact, it is true that state and city regulations practically disregard flywheels, but we have boiler regulations wherever we turn. It must be only a question of time when regulations and laws will protect lives and property against flywheel accidents, as they now protect them against other hazards.

The limiting speeds for flywheels and pulleys of the best design have been determined theoretically and by tests, and the figures agree very well. We know that a given wheel cannot speed beyond a certain point without giving way, and the speed depends among other things upon the type of wheel.

Users of flywheels have bought their engines and other machinery equipped with flywheels, and they have assumed the flywheels were safe for the speeds specified. Some purchasers have gone farther than this; they have treated their flywheels and pulleys as they would their automobiles and they have run them at as high speeds as conditions outside of safety would permit. They have learned that faster working machines, in many cases, increase output and they have speeded up without giving the flywheel a thought.

Nearly all factory men have heard that the belt has a limit of speed beyond which there is disadvantage in going. This has been the salvation of the pulley, for it has held down the rim speeds of pulleys. It should be remembered, however, that a split cast-iron pulley, or a flywheel with a flanged joint carrying a belt which runs at 5000 ft. per min., is going altogether too fast. A solid cast-iron pulley can run at about 6100 ft. per min. and still have a factor of safety of 10 which is the figure that should be used in pulley and flywheel work.

Unfortunately, the correct speed for the belt does not always hold down flywheel speeds. For example, one might have an engine direct connected to a line shaft having pulleys, let us say 4 ft. in diameter. This engine might have a flywheel 10 ft. in diameter. The flywheel speed could then be in the neighborhood of 12,000 ft. per min. without overspeeding the belts.

COMPUTATION OF STRESSES

THERE ARE three types of wheels in common use; the flywheel with a single-piece rim, the flywheel with a split rim and with a link joint, and the flywheel with a split rim and with a flange joint. The solid wheel can be used only if the diameter is less than 10 ft. on account of the difficulties in construction and shipment. The link jointed wheel can be conveniently adopted only where the rim is thick and since such a rim is not frequently used for belt or rope driving; where such a drive is necessary, a solid wheel or a flange jointed wheel is used.

One can usually get an idea of the safety of his flywheel equipment from the rim speeds; but since the computation of the rim speed requires the multiplication of three figures, namely, the revolutions per minute, the diameter of the wheel, and the constant 3.1416, it has been found more convenient to omit the constant 3.1416 and to think of flywheels in terms of the revolutions per minute and the diameter.

The following tabulation shows the products of the revolutions per minute and the diameter which should not be exceeded, if it is desired to keep the factors of safety at 10 or above:

a—For solid cast-iron flywheels, the product of the revolutions per minute and the diameter (in feet) should not exceed 1937.

b—For link-jointed cast-iron flywheels, the product of the revolutions per minute and the diameter (in feet) should not exceed 1500.

c—For flange-jointed cast-iron flywheels, the product of the revolutions per minute and the diameter (in feet) should not exceed 968.

If, in any case, it is found that the product referred to above exceeds the figures suggested for the type of wheel which is operating, a further investigation of the conditions should be made.

The diameter referred to above is not to be taken as the outside diameter of the wheel but as the mean diameter of the rim.

From Marks, Kent and similar handbooks, we may obtain formulas for centrifugal force which can be finally worked into the following:

Stress in a cast-iron rim, due to centrifugal force, equals $0.000,266,4\ (RD)^2$.

If we take the accepted figure of 10,000 lb. per sq. in. as the maximum tensile stress which a cast-iron rim is capable of withstanding, and use a factor of safety of 10, which means an allowable stress of 1000 lb. per sq. in., we have—

1000 equals $0.000,266,4\ (RD)^2$ or RD equals 1937.

*Paper read at the convention of the National Safety Council.

A joint in a flywheel is like a riveted joint in a boiler, in that one cannot exceed a certain efficiency. For a flange-jointed wheel, this maximum efficiency is 25 per cent. Therefore, while we can allow a stress of 1000 lb. per sq. in. in a rim of the solid wheel, we should limit ourselves to 250 lb. per sq. in. in the rim of the flange-jointed wheel. Then in this case—

250 equals 0.000,266,4 $(RD)^2$ or RD equals 968.

Because the efficiency of a link-joint does not exceed 60 per cent,

600 equals 0.000,266,4 $(RD)^2$ or RD equals 1500.

Now, having the speeds of several wheels at which we will have factors of safety of 10, the next question to be determined is the probable bursting speeds. Since the stress increases with the square of the speed, it follows that the wheels can operate not 10 times as fast but $\sqrt{10}$ times as fast as is indicated by the figures above, before they will actually burst. The $\sqrt{10}$ is approximately 3.16, therefore the highest speeds which wheels are likely to be able to attain are:

a—Solid wheels 6120
b—Link-jointed wheels 4740
c—Flange-jointed wheels 3059

In order that you may know the approximate factors of safety of your wheels, the following formulas may be applied:

For a solid wheel the factor of safety equals

$$(1937)^2 \times 10 \div (RD)^2$$

For a link-jointed wheel the factor of safety equals

$$(1500)^2 \times 10 \div (RD)^2$$

For a flange-jointed wheel the factor of safety equals

$$(968)^2 \times 10 \div (RD)^2$$

As explained above, the figures given are those for wheels with the best possible design of joint.

Therefore, if you make a computation from any of the formulas used above, you may be sure that your wheel is not better than the result obtained from an application of the formula, but that it is less good if the design is not of the best.

The engineer who is called upon to investigate a flywheel, finds it necessary to measure that wheel very carefully and to make practically a duplicate of the original flywheel drawing. From this he determines the stresses in the various parts of the wheel. Link-jointed wheels and flange-jointed wheels furnish complicated mathematical problems for him. A few assumptions are necessary. Most of these happen to fall on the side which would indicate the flywheel to be safer than it is, so that when the engineer has made his computation he can only say to you, "I know that the stresses are this high and I do not know how much higher they may be. Similarly, I know that the factor of safety is not above this figure."

One assumption which is frequently taken exception to but which, nevertheless, is justified, seems to fall on the side of indicating the wheel less safe than it actually is. The assumption is to the effect that the flywheel is a ring revolving in space; in other words, it assumes that the spokes do not tend to hold the wheel together. While there undoubtedly are wheels which are partially held in place by the spokes, there have been enough cases proven of actual compression against the spokes to justify those who calculate wheels in considering that the spokes at least do not help to hold the rim together.

If the engineer could watch the erection of the flywheel and could make a record of the conditions existing as the flywheel goes into place, much that is later questioned could be answered. I have in mind a corporation in Chicago which erected a power house and put in a number of reciprocating engines. Link-jointed flywheels were used, since the engines were direct connected to generators and since belts and ropes were unnecessary. When the last link was cooling down, after it had been shrunk in place, it broke. This made the company which had bought the wheels suspicious and they drilled a small hole in each of the other links. Although the link was several inches wide and the hole was probably only ¼ in. in diameter, the removal of this small amount of material was of sufficient importance so that several other of the links broke. The reason for the breakage was that the links had been made too short in the first place. Consequently, it had been necessary to heat them very hot and as they cooled to the room temperature the stress put in them was too great. It exceeded the strength of the link in only one case but had the other wheels been run up to speed it is quite possible that all of them would have broken. Had the erecting engineer carefully measured the link itself and the place where it was to be fitted, he could have determined the stress that would have been put in the link after it had cooled; or had the company's engineer noted the high temperature to which the links had been heated, he would have known that there was something wrong in the design.

Any company which has important wheels to set up should assure itself that matters of this kind are not overlooked, since it is practically impossible to determine conditions after erection without tearing the wheel down.

Causes of Flywheel Accidents

While the principal cause of flywheel accidents comes from overspeeding, which may be normal or momentary, there are many contributing causes and several independent ones. The principal divisions are overspeeding, overloading, and failures due mainly to defects, flaws and improper handling. The causes of overspeeding may be divided and sub-divided as follows:

a—Normally high speed not necessarily exceeded when wheel breaks. (Failure due to this cause is frequently in combination with "a," "b" or "c" under the next heading.)

b—Breaking of engine parts.

c—Breaking of engine belt.

d—Engine belt running off flywheel.

e—Breaking of governor belt.

f—Slipping of governor belt.

g—Governor belt running off pulley.

h—Derangement of governor, which may be subdivided as follows:

1. Struck by flying parts.
2. Failure of governor pulley.
3. Loose or lost set screw.
4. Loose or lost key.
5. Gear or gears broken.
6. Fly ball off.
7. Parts broken or sheared off.
8. Insufficient lubrication.

i—Derangement of governor valve gear.

j—Loss of load (frequently when an engine speeds slightly, the first act on the part of men operating ma-

chines is to throw off these machines. This increases the likelihood of the engine speeding.)

k—Circuit breaker blown out, burning out of armature, or electrical load otherwise dropped.

l—Improper adjustment of engine stop, governor, or valve gear, or governor or valve gear parts blocked or otherwise made inoperative, or engine stop out of commission.

Overloading may be divided as follows:

a—Clogging of machinery in mill.

b—Unusual number of machines forced at same time.

c—Careless or ignorant handling of friction clutches.

d—Short circuit of driven electrical machinery.

e—Sudden stoppage of engine.

Some of the miscellaneous causes of flywheel accidents may be divided as follows:

a—Failure of wheel due to flaw.

b—Failure of wheel due to improper material (for instance, too high a percentage of phosphorus in a wheel is likely to make it brittle. Jobbing foundries frequently use phosphorus for small moulds, which must flow readily. The effect of phosphorus in iron is to make it flow at a lower temperature than if the phosphorus were not present.)

c—Failure of wheel due to crystallization.

d—Failure of wheel due to internal stresses.

e—Failure due to accidents to engine.

f—Failure of wheel due to improper design.

g—Failure due to dirt or foreign materials carried in rim.

h—Failure due to holes drilled in rim.

i—Failure due to increasing diameter by adding on to rim.

j—Tight keys.

k—Wheel struck by flying objects.

l—Belt pull.

m—Loose bearings.

Of the foregoing causes, derangement of the governor is probably the principal one, and broken belts the next most important.

Remedies for Dangerous Conditions

Generally speaking, remedies which can be applied for the prevention of flywheel accidents, may be found among the following:

a—Better governors:

1. Triple rope drive instead of single belt drive for governor.

2. Governor sheaves to be keyed, and the unused portions of keyways to be filled in.

3. Governor sheaves to have suitable guards of substantial construction.

4. Safety cams on all Corliss valve gears.

5. Guards around governors.

6. Governor gearing enclosed in oil-tight covers, readily detachable for inspection.

7. Couplings, set screws, keys, bolts, etc., in moving parts countersunk.

8. Better care of governors.

b—Better care of engine parts, belts, etc.

c—Lower flywheel speed:

1. Two small wheels instead of one large one.

d—Solid wheels instead of jointed wheels, or link-jointed wheels instead of flange-jointed ones.

e—Steel, wood, or other wheels adapted to high speeds instead of cast-iron wheels.

f—Better design of equipment:

1. Avoidance of overload.

2. Arrangement of steam piping to avoid breakage.

3. Avoidance of materials fastened on outside of pulleys or flywheels, and avoid holes drilled in such pulleys or flywheels.

4. Locate engines and equipment so that the least possible damage will be done in case of breakage.

5. Space in flywheel pits for broken bolts.

6. Signals from engine room to machine room, and vice versa.

7. Engine stops.

8. Automatic valves on boilers.

9. Bracing of dangerous wheels with tie rods.

10. Frequent operation and testing.

The Better Types of Wheels

The table below, which is made up for 10 ft. cast-iron wheels, shows the relative balancing effect of wheels at various speeds and the factors of safety of two types of wheels, the increase of speed necessary to break the wheel, and relative elapsed times necessary to reach breaking speed. It should be understood that the balancing effect and the times necessary to reach breaking speed are relative figures only.

Ten Foot Diameter Cast-Iron Wheels

	Flange Jointed Wheel				Solid Wheel		
Revolutions per minute	Balancing effect	Factor of safety	Increase of speed necessary to break	Time to reach breaking speed	Factor of safety	Increase of speed necessary to break	Time reach breaking speed
96.87	1	10.00	2.16	1	40.00	5.32	4.33
150.00	2.41	4.16	1.04	0.84	16.62	3.08	4.18
193.74	4.00	2.60	0.58	0.67	10.00	2.16	4.00
306.00	10.01	1.00	0.00	0.00	4.00	1.00	3.33
612.00	40.00	.....	....	....	1.00	0.00	0.00

Referring to the table, the advantage of the solid wheel over the flange-jointed wheel is readily understood. Take, for instance, the third line table. This assumes a 10-ft. wheel to be operated at approximately 194 r.p.m. The balancing effect of two wheels is naturally the same. The factor of safety of the solid wheel is four times as great as that of the flange-jointed wheel. It must be increased in speed another 216 per cent before it breaks, whereas the flange-jointed wheel need be increased only 58 per cent. While this increase is going on, the engineer has six times the time to get the engine stopped that he would have with the flange-jointed wheel. If, for instance, the time with the flange-jointed wheel should be 10 sec., he would have a full minute to stop an engine carrying a solid wheel. Few engineers could be expected to get the steam shut off their engines in 10 sec.; most of them could do it in a minute if they had the nerve to make the attempt.

Solid case steel wheels or built-up steel wheels are capable of running at higher speeds than cast-iron wheels. Wooden wheels also may run faster than cast-iron wheels, provided they are properly made. A well made wooden wheel may be run about 54 per cent faster than the best cast-iron solid wheel and a well made built-up steel wheel may be run about 88 per cent faster than solid cast-iron wheel. Usually, however, cast-iron wheels, because of their lower cost, are adopted.

Distilled Water for Boiler Feed

IT IS RECOGNIZED that water for boiler feed should be as free as possible from impurities, especially when the boilers are forced heavily above rating. One method of obtaining pure water is by means of evaporators, using steam as a heating medium, and this practice, which has been common for marine plants is now coming into frequent use for stationary plants.

Evaporation may be accomplished by means of one or a series of units depending on the amount of pure water needed, and the steam economy for which it will pay to provide. In either arrangement, water is boiled by being brought into contact with coils containing steam of a temperature above that of the water, and the vapor from this boiler is condensed by passing it through coils over which flows water of a lower temperature. By using evaporators in series, the vapor formed in the first is used to boil water at a lower temperature in the next, thus condensing the vapor first formed, and so on, a pound of steam may be made to produce several pounds of distilled water. The greater the number of evaporators in series, the higher will be the cost of the plant, and the number that it is wise to use will be determined by balancing the overhead cost of the installation against the saving in fuel cost.

Figure 1 illustrates the principle of action of a 4-effect plant, using four evaporators and a condenser with steam at 125 lb. pressure. One hundred pounds of steam will evaporate about 80 lb. of water in the first effect, at a pressure of 70 lb. In the second effect this 80 lb. of vapor will evaporate 0.8 as much water or 64 lb., at 34 lb. pressure, and so on; the pressure in third and fourth effects being 11 and 1 pound respectively, and the evaporation 51 and 41 lb. The total evaporation is the sum of that in the four effects or 236 lb. of pure water from 100 lb. steam. Condensed vapor from the second, third and fourth effects and the condenser is and, to heat it still further, it may be sent through a heater located between the last effect and the condenser.

It is pumped successively through the fourth, third, second and first effects, so that each effect not only evaporates water but serves as a preheater for the effect

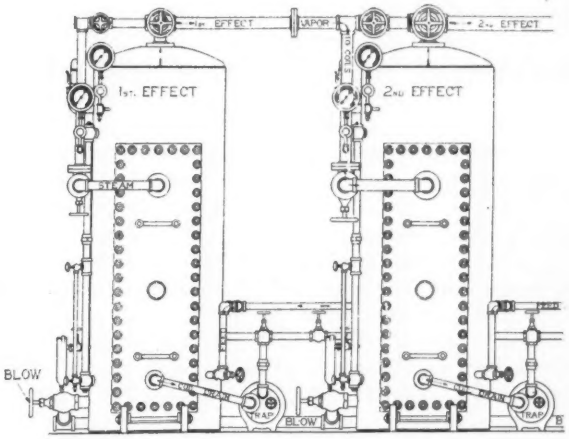


FIG. 2. DETAILS OF CONNECTIONS FOR TWO EFFECTS

of next higher pressure. Impurities and sediment deposited in each evaporator are blown off to a common waste water line. Details of connections of a first and second effect are shown in Fig. 2.

The same process may be used to get distilled water for ice making. In an absorption plant, steam may be

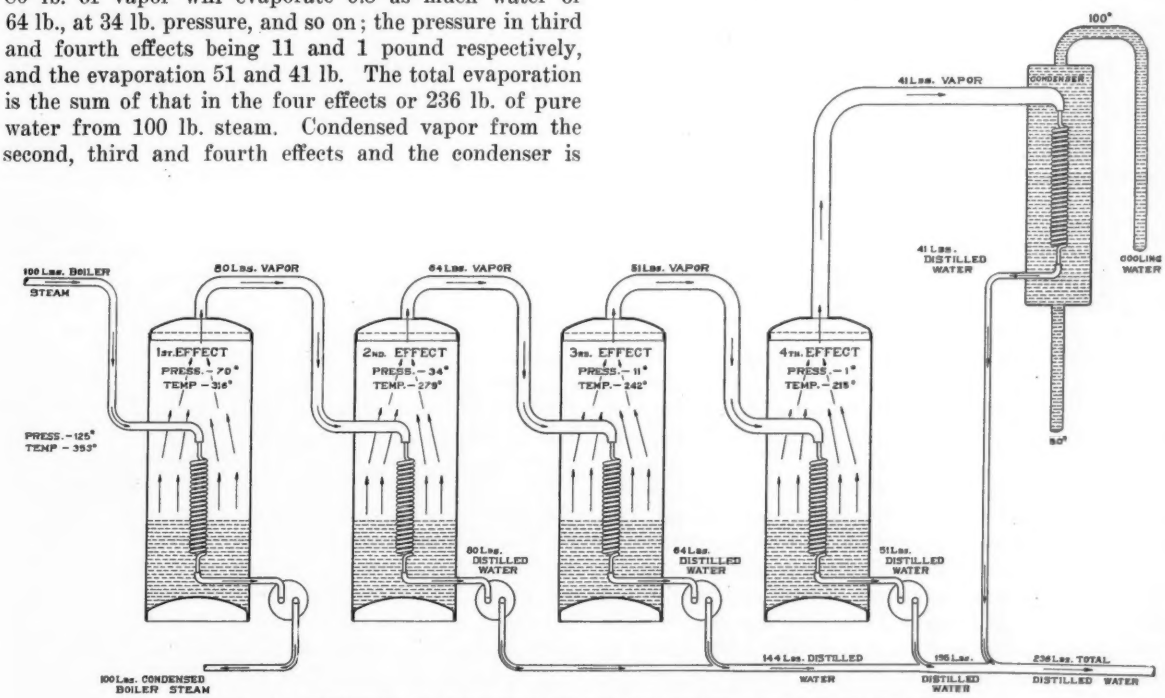

100 Lbs. BOILER STEAM
80 Lbs. VAPOR
64 Lbs. VAPOR
51 Lbs. VAPOR
41 Lbs. VAPOR
100°
CONDENSER
41 Lbs. DISTILLED WATER
COOLING WATER
80°
1ST. EFFECT PRESS. – 70° TEMP – 316°
2ND. EFFECT PRESS. – 34° TEMP. – 279°
3RD. EFFECT PRESS. – 11° TEMP. – 242°
4TH. EFFECT PRESS. – 1° TEMP. – 215°
PRESS. – 125° TEMP – 353°
80 Lbs. DISTILLED WATER
64 Lbs. DISTILLED WATER
51 Lbs. DISTILLED WATER
100 Lbs. CONDENSED BOILER STEAM
144 Lbs. DISTILLED WATER
196 Lbs. DISTILLED WATER
236 Lbs. TOTAL DISTILLED WATER

FIG. 1. PRINCIPLE OF MULTIPLE EFFECT EVAPORATION FOR DISTILLED WATER

led away to a pure water storage, the condensed steam from the first effect being returned to the hot well for boiler feed or other use.

In practice, the water to be evaporated is taken from the discharge from the condenser, thus saving some heat, sent to a single effect evaporator at boiler pressure, condensed into distilled water and used to produce steam at lower pressure for use in the generators. In a compression plant, an evaporator is substituted for the steam condenser taking steam from the main engine and aux-

iliaries at atmospheric pressure and evaporating water under a slight vacuum.

Where high steam economy is desired, heat exchangers may be provided to extract the sensible heat from the condensation of the higher pressure effects and use it to maintain higher temperature of the vapor going into the lower effects.

Pulverized Mine Waste Gives High Efficiency

A SERIES of tests on burning mine waste has recently been completed by La Societe des Mines de Houille de Blanzy, at Montceau-les-Mines, and clearly demonstrated that mine waste of not over 1/16-in. size, which corresponds in analysis to low grade American anthracite or river coal, could be burned in pulverized form under boilers with a combined furnace and boiler efficiency, ranging from 82 to 85 per cent, although the boiler used was not equipped with either superheater or economizer.

The fuel employed corresponded, after drying, to the following average analysis:

Ash	29.2 per cent
Volatile matter	11.2 per cent
Fixed carbon	59.1 per cent
Moisture	0.5 per cent
B.t.u. per pound	10,728

Fusing temperature of ash from 2120 to 2228 deg. F.

The installation for the test consisted of one Babcock & Wilcox boiler, having 2368 sq. ft. of heating surface. The test consisted of an uninterrupted 30-day run of 704 hr. During this period the hourly evaporation for each 10 sq. ft. of heating surface was 30.19 lb. of water which exceeded the 29 lb. guarantee.

Evaporation of from 36 to 34 lb. of water per 10 sq. ft. was easily attained for period of several hours at a time.

The average evaporation per pound of coal was 6¾ lb. of water, which also well exceeded the guaranteed performance of 5½ lb.

During the first 12 days of the test, the best method of operation and regulation was determined, and once having been attained was maintained until the end without any difficulty. The hourly evaporation per 10 sq. ft. of heating surface showed an average of 30 lb. of water, and the average evaporation per pound of fuel was 7.38 lb. of water, which corresponds to an overall efficiency of 82 per cent for furnace and boiler.

During periods of more than 48 hr. the evaporation per pound of fuel was maintained between 7.61 and 7.65 which is equivalent to an efficiency of 85 per cent.

During the whole time of the test, the ash was extracted easily, partly in a state of dust and partly in a spongy and vitrified state. The smoke leaving the stack was light and of a clear color and caused no deposit of dust in the neighborhood or surroundings of the installation. After cooling off, the combustion chamber was found in good condition and ready to operate again without making any repairs whatever.

Coal preparing and burning equipment consisted of one 5-roller pulverizer, one dryer, two powdered coal feed controllers and two low pressure burners at the combustion chamber with the necessary blowers for supplying air, for carrying the coal from the powdered coal feeders into the burners.

The equipment for the powdered coal installation was manufactured in France along American lines with the assistance and guidance of Quigley Fuel Systems, Inc.

The Sarcastic Engineer

By Robert Grimshaw

DOBSON'S new engineer is like a rack comb—all back and teeth. He never has a pleasant or an approving word for anybody or anything. His food must taste bad to him. He is sarcastic to an extreme, and nobody is safe from the keen edge of his oral stiletto. If he always were right, it would not be so bad; but sometimes, in the effort to be sarcastic he makes himself ridiculous. Of course that takes the edge off the sharp sayings. He reminds me of the man who when he objected to an estimate as being unsatisfactory, and was told that it was only approximate, replied with a cream-of-tartar accent, "Yes; very approximate!"

When his opposite neighbor dropped in for a moment to get acquainted and pass the time of day, and exchange notes about his new rope drive, the man of sarcasm asked him if he had decided to use Clark's or Coates' cotton thread for his main drive. When the carpenters were putting up the new "balloon frame" dry-house, he called one of them to him and said that they were the smartest carpenters he had ever seen.

"How so?" said the wood butcher with an 8-in. smile and expectant air.

"First men I ever saw who could drive a 10-penny nail in a match," quoth the throttle-twister.

When this engineer's neighbor had his stack raised 10 ft., to combat the influence of a near-by high roof, he asked him where his wire netting was.

"What netting? Where?" was the puzzled query.

"On top of the stack. To catch the coal and fire tools," was the reply.

Now that sort of a thing don't pay—as a steady diet. Once in a while, a bit of fun does more good than a bit of earnest; but sarcasm is a boomerang. That man's manner is a direct business injury to Dobson, if you look at it rightly. A man with that unfortunate habit (it is a vice, by rights, and as such should be punished) can form no real friendships and have no improving conferences in reference to his daily work. He will know less in June, 1923, than in June, 1922; while less sarcastic—and perhaps less intelligent—engineers will know more, if they live so long; and if they die before that time will have friends to give them decent burial.

The sarcastic engineer—in fact, any sarcastic man—is debarred from the advantages of friction of ideas—the only kind of friction that ought to be encouraged. He is cut out from the change to trade one piece of experience for two—which can almost always be done when three or four men of a craft get together for a "gam." In fact, it is not always the fellow-craftsman from whom the best points can be had. "The man up a tree" can often see more than "the man in the street." Even the greatest inventions are not always made by men in the line in question. Corliss was a country shop keeper; Porter, of the high-speed engine, a lawyer; Morse, a portrait painter. You never know.

A Balky Air Pump

WHY IT DROPPED THE VACUUM, AND HOW IT WAS CURED. BY JOHN U. MORRIS

WITH very rare exceptions, all new installations start out developing some sort of "bad habits," many of which can be remedied by a change in operation, and some which cannot because they are due to an oversight in design or to unavoidable conditions under which the plant operates. One such "bug" which came to my attention will be described in what follows.

In a metropolitan section that must have continuity of service with no exceptions, and where any failure of a prime mover was a cause of great worry to the management, a new 35,000-kw. generating unit was installed. It had as auxiliaries a 60,000-g.p.m. circulating pump, two hot well pumps (one for reserve), and an A.E.G. air pump, better known in this country as a turbo-air pump. This last was one of the chief actors in making trouble, though due to no fault of the pump itself.

The turbo-air pump was installed in the usual way, Fig. 1, with hurling water taken from the discharge of the circulating pump through twin strainers and a 9-in. line; the suction was from the top of the hot well through a 14-in. line, and the discharge was to the sewer.

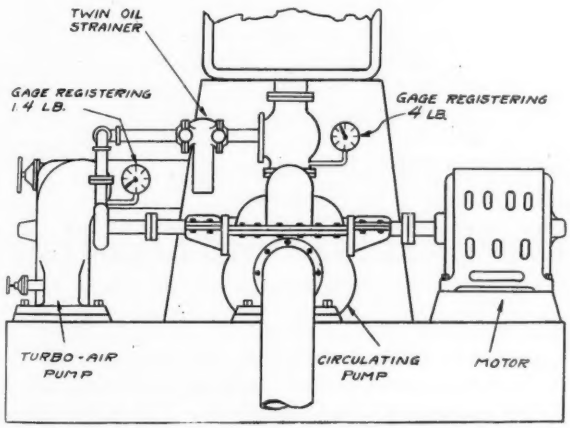


FIG. 1. CONNECTIONS OF TURBO-AIR PUMP AND ARRANGEMENT OF GAGES

When the pump failed to function, not only was it useless in maintaining vacuum, but air and water from the circulator discharge were drawn into the condenser by the vacuum. If the oiler or engineer who was standing by did not work double quick and close the 14-in. valve, the vacuum would drop to zero in less time than it takes to tell it.

In the effort to locate the trouble, the pump was examined many times, but was found to be all right, and in fact, if started up again after the trouble, would go along all right. After much bother had been experienced, it was discovered that small bits of refuse that got by the strainers were the cause of the difficulty; also that shuttng down the pump and reversing its direction of motion for a few turns by means of a 12-in. Stillson wrench applied at the shaft coupling would clear the pump so that it would work properly for an hour or more.

We could tell when the pump needed a wash out by the gage on the hurling water suction line, put there for that purpose. With 4 lb. on the circulator discharge, the gage would show about 1.4 lb. at the pump; when this began to go up, it was a pretty sure indication that the proper amount of hurling water was not being drawn to the pump. Tide variations made some difference of course and had to be taken into consideration.

Once, when the machine was coming out of service for a time, I had opportunity to open up the inspection handhole and examine the impeller and diffusion blades, Fig. 2, before the pump was cleared and washed out. Matches and fine strings were caught in the bronze blading, thus breaking the water slug and preventing the

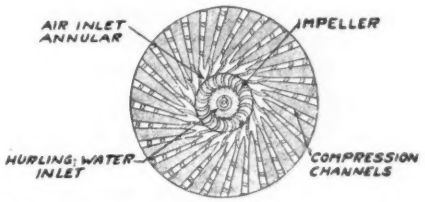


FIG. 2. SECTION OF IMPELLER AND DIFFUSION BLADES OF TURBO-AIR PUMP

diffusion channel from functioning. When a sufficient number of channels failed to work, the whole pump cycle reversed with consequent drop in vacuum.

To remedy the difficulty, it would be possible to use a finer strainer, but that would involve clogging the strainer with the fine material to the point that the suction would be impeded, and frequent cleaning of the strainer. Another method would be to use, as is done at the Denver Gas and Electric Co., a turbo-air pump mounted on a cooler so that the same water is used continuously; but as the vacuum with this type of pump is directly dependent on the temperature of the hurling water, it is obvious that better vacuum can be obtained by using water from the discharge of the circulating pump which will always be cooler than can economically be had from a separate cooler for the air pump water.

As a safety precaution, I believe that a special check valve as shown in Fig. 3 would work out satisfactorily.

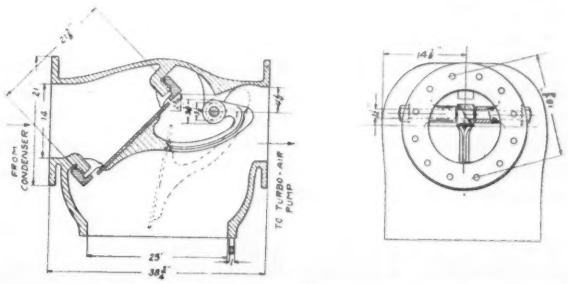


FIG. 3. SECTION OF PROPOSED CHECK VALVE FOR AIR PUMP HURLING WATER SUCTION

Assuming that the pump dropped its vacuum, any great amount of water going to the condenser would close the check valve and hold the vacuum there so that the drop would be negligible; the pump could then be cleared and started again without interfering with the operation of the plant. Some sort of tell-tale device should be provided to indicate whether the check valve was open or shut.

One engineer in charge of a watch insisted that the pump be shut down and cleared every hour. This seemed like a sensible precaution, but on two occasions, when the water must have been full of matches, she failed to hold vacuum in less than 5 min. after having been cleaned. It is, of course, impossible to have a man with his eyes glued to a vacuum gage for three-fourths of the time, and even if it were possible, the vacuum would be sure to fail just during the time he was not looking.

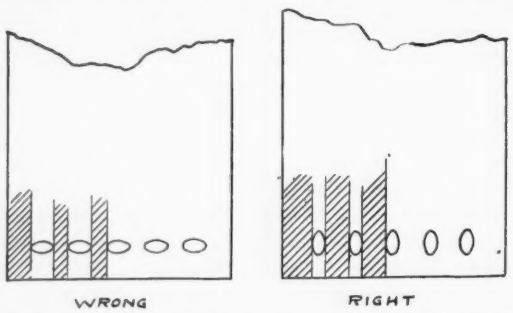
The remedy suggested, using a special check to hold the vacuum in the condenser while clearing the pump, would cost but little and I believe it is worth trying.

Punching Belt Holes*

By W. F. Schaphorst

I SHOW HEREWITH the wrong and right way to punch holes in a belt preparatory to lacing.

Oblong (elliptical) holes are preferable to round holes, but they must be placed so that the "long" axis of the hole lies parallel with the belt. In this way, more "useful belt" is left as indicated by the cross lines in the sketches. There is considerably more shaded area where the method is right than where it is wrong. It will be



RIGHT AND WRONG WAY OF PUNCHING BELT HOLES

noted by exaggerating the punch hole—making it much longer than wide—the whole belt would be cut in two and then it would be of no service at all. By turning the punch 90 deg., as shown in the sketch marked "Right," maximum strength is obtained.

The efficiency of a leather belt joint may be computed in the same way that the efficiency of a boiler joint is computed. In both cases, it is best to cut away as little of the stressed material as possible. That is, make the area of the stressed section, shown shaded in these sketches, as great as possible.

Colorado Utility Men Discuss Live Problems at Convention

AT ONE of the best conventions ever held by Colorado utility men, The Colorado Electric Light, Power and Railway Association in joint session with the Rocky Mountain Division of the National Electric Light Association at Glenwood Springs, Sept. 11 to 14, discussed such subjects as taxation, bankers' relation to public utilities, financing rural extensions, public utility community interest, and allied subjects.

In discussing the "Electrify America" program, J. E. Davidson, vice-president of the National Electric Light Association, stated that the electric light and power industry and its allied industries in the utility business, including street railways, gas and telephone companies, are among the largest contributors to the nation's prosperity. The electric light and power industry is the third largest in the United States, being exceeded only by the railroad and packing industries.

They need at this time, he said, $1,000,000,000 a year for 7 yr. in order to make the required extensions and expansions, which in many instances were held up by the war. He also urged the promotion of the "Electrify America" program through local effort.

During the course of the business sessions, the name of the state association was changed to Colorado Public Service Association, the change being made so that gas companies might be admitted.

In the election of officers for the ensuing year, the Electric Light men elected J. F. Dostal, of the Colorado Springs Light & Power Co., president; D. C. McClure, of the Denver Gas & Electric Light Co., vice-president; Norman Reed, of the Denver Power Co., second vice-president; A. C. Cornell, of the Western Electric Co., of Denver, treasurer, and O. A. Weller, of the Denver Gas & Electric Light Co., secretary.

The Colorado Public Service Association elected W. F. Brown, traffic manager of the Mountain States Telephone & Telegraph Co., Denver, president; Ernest Stenger, receiver of the Denver Tramway, vice-president; C. N. Stannard, general manager of the Denver Gas & Electric Light Co., second vice-president, and Miss Minnie Baker, Denver, secretary.

The Financially Efficient Engine Load

By Robert Grimshaw

CONSIDERING the term "full load" to mean the efficient load, it is evident that operating at less than that—say at half load—we are increasing the cost per horsepower-hour for steam. The total operating costs remain the same, but are doubled per horsepower. The physical depreciation may be a trifle less, but not provably or calculably; so they will also be doubled per horsepower-hour. For operation and depreciation we are paying for two horsepower for every one that we use; and for steam we are paying readily calculable excess.

If, on the other hand, we run with overload—say one-fourth more than the efficient or "full" load—we have per horsepower-hour:

(1) Increased steam consumption and steam cost per hour.

(2) Decreased operating costs—subject, however, to a slight uncalculable and perhaps unprovable correction for wear and tear.

(3) Decreased depreciation reserve, subject perhaps to (uncalculable) correction by reason of the greater wear and tear due to heavier stresses.

Evidently, to be financially most efficient we must find that load point at which the extra steam cost per horsepower-hour balances the extra operating and depreciating costs.

* All rights reserved by author.

Undercutting Commutators

THE ARTICLE on the "Care of Commutators" by Walter J. Stewart in the Sept. 15 issue, is quite to the point and one of great interest to those who may have d.c. machinery under their charge.

The practice of undercutting mica insulation of commutators is one that is yet to be proven correct, and I have abandoned it after a thorough trial.

I have found that my motors and generators have given me more trouble, at the commutators and brushes, from sparking across the bars and at the point of brush contact, where the mica has been undercut, than where the commutator is smooth, and insulation is left as it is when turned.

A carefully turned commutator, either on centers or in the bearings, and the proper dressing with a good commutator stone when needed, will keep any commutator in as good condition as can be had, without the need of undercutting and its consequent cost and trouble, and the chance of the slots collecting carbon dust and dirt is wholly eliminated.

My experience with d.c. machinery dates back to 1892, and up until 1916 I never ran an undercut commutator. In the fall of that year, frequent articles began to appear in the trade papers, as to the advisability of undercutting the insulation of commutators. These led me to try the scheme on a 75-kw. direct connected generator that seemed to have the mica too hard. This machine was used for night lighting of the town, and was so arranged that should anything happen we could cut in on a motor-generator set that was driven from outside power. In starting the 75-kw. unit, the brushes began to chatter, and as the brush face covered 2½ segments of the commutator, I was at a loss to account for the chattering. We smoothed the commutator carefully with sandpaper, but the chattering did not stop. We then relieved the heel and toe of each brush slightly, which helped things a lot for several days; but the brushes seemed to wear much faster than before, and where the mica had been cut away were practically filled with dust and dirt. Harder brushes were tried and no better results were obtained than before. We finally had to turn the commutator down until it was a smooth surface and all chattering and noise disappeared.

To my knowledge, several street railway companies have tried undercutting on the car motors and have stopped it as being more of a menace than otherwise.

When I turn a commutator, I run the work as fast as the tool will stand, and not burn the point, and use a V pointed tool with a fine feed; by doing this, I find that none of the copper will pull across from one segment to the other, and a smooth job is the result.

On one thing, however, I must disagree with Mr. Stewart; that is on the use of babbit, babbit lined or die cast bearings for motors. Any bearing made of these metals is a source of constant danger, for should they become hot they will run out and allow the armature to strike the fields with the consequent big repair bill. What he says regarding a bronze bearing cutting the shaft if it gets hot, is true; but, of the two evils, I prefer the lesser, and would much rather turn the shaft than rewind the armature.

CHARLES N. SHAW.

Eliminating Secondary Pipe Lines; Repairing Roller Bearing

A LARGE water filter is used to furnish filtered water for manufacturing purposes, feeding two large hot water tanks and for boiler feeding. The difficulty here had always been that when it was necessary to shut off the water filter for any length of time the water would be

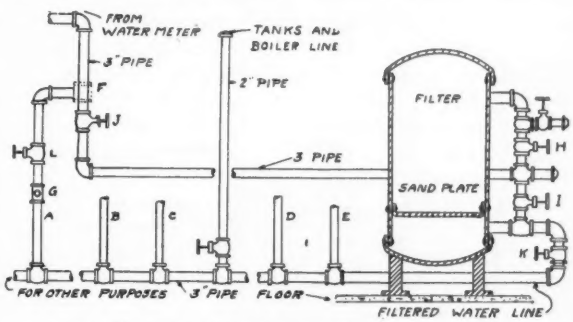


FIG. 1. PIPING ARRANGED TO BY-PASS FILTER

shut off on the entire water system used for manufacturing purposes during this time. Then water had to be taken from the tanks for boiler feeding and if the filter was out of service for any length of time, the tanks, which are made of wood and located in a warm place, would dry out quickly, and when they were filled again they would leak badly.

The arrangement of the water filter and pipe system is shown in the illustration where it will be noticed that the filter receives the water from the city main, through a 3-in. pipe which is about 150 ft. long. After the water passes through the filter it goes to the apparatus that uses the filtered water as shown at A, B, C, D, E. The pipe feeding these branches is also a 3-in. This also feeds the two tanks and furnishes feed water for the boiler, etc.

It was decided to run a main pipe line directly from the meter to the tanks and other points of use but further investigation showed this line would not be necessary. A tee placed at the point F in the main line, as

shown by the dotted lines, and connected into one of the branch lines of the apparatus that used water as shown at G would do all that was required. With this arrangement, should the filter get out of order for some reason, the valves H. I. on the filter are closed, also the valve J is closed should one of the valves on the filter leak. Then valve K is closed while valve L is opened. In this way, the entire system receives water with the filter out of service.

Thus familiarity with the piping system saved expense and labor, also kept another pipe line from running through the plant, which perhaps would be in service only a few times during the year.

Some time ago I had the job of repairing a machine gear which ran loose on a shaft. In removing the gear from the shaft, I found the gear contained a bearing of a roller type which was worn beyond repair due to lack of lubrication.

I took the gear to a machine shop and had them make two concentric cast-iron bushings, one to fit inside the bore of the gear hub and the other to fit around

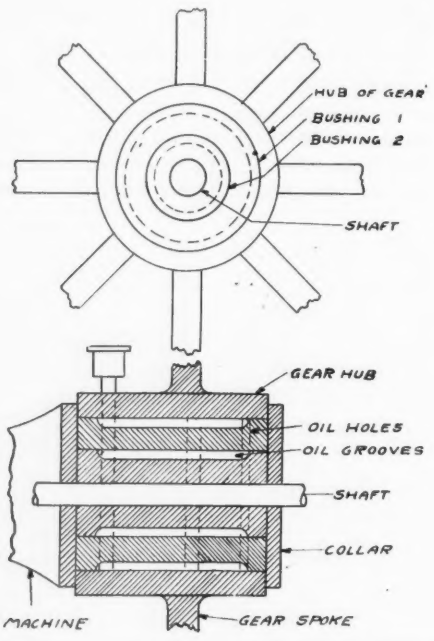


FIG. 2. END VIEW OF GEAR HUB AND BUSHINGS
FIG. 3. LONGITUDINAL SECTION THROUGH GEAR HUB

the shaft over which the gear runs. The arrangement of the bushings is shown in the end view, Fig. 2.

The bushings are 4 in. long and have quite a numbers of oil holes through them as well as a number of oil grooves on their bearing surface, as shown in Fig. 3. They are lubricated by means of a grease cup through the gear hub as illustrated.

I have found that this makes an easy running bearing. As there are three rubbing surfaces should one run dry or perhaps stick from some cause the bearing will not run hot or cause any other trouble as there are two more bearings that will turn. This gear runs at a high rate of speed; for this reason roller bearings are used, which also is the reason that I decided on the two bushings. H. A. JAHNKE.

Relieving Pipe Strain

WHEN INSTALLING short lengths of steam pipe, say from 10 to 25 ft., the flange faces are often so close together that considerable strain is necessary to separate them enough to allow space for the gasket. The suggestion has been made to reverse this plan, have the flange faces far enough apart so that considerable force is required to draw the flanges into permanent place after the gasket is installed. When this method is used, considerable longitudinal expansion can occur before any severe strain or longitudinal stress takes place on a hot pipe.

When this plan is used, the flanges should be extra heavy, for the longitudinal stress is placed upon the pipe when it is cold through the pressure exerted by drawing up the flange bolts, although the strain will be reduced when the pipe is hot, which is the most dangerous time to pipe fittings and valves. When this plan is followed, it is an easy matter to remove a length of such flanged pipe when it is cold. This is no small advantage when dismantling 5 or 6-in. pipe lines. Of course, the idea is to use the system on straight runs where there is small chance to spring the pipe from elbows or bends. JOHN THORN.

Cutting In a New Alternator

THIS METHOD of cutting in a new alternator may not be new to some old operators; but I and many more who might read it are not old operators, and anyway, it is new to me, for it is a method that I devised after making a few sad mistakes while changing from one generator to another.

You can pick up almost any technical book, handbook or magazine and find a whole lot written about the proper division of load between alternators when they are being run in parallel; but there isn't much written about the evil effects of improper division of load when a new alternator is put on the line and the one that has been carrying the load is taken off. For instance, in our plant there are two alternators, a 2000-kw., which we will call "A" for convenience, and a 1000-kw., which we will call "B." Almost all of the time "A" carries the load alone; but at times we have to run them in parallel and then at other times the load is such "B" can carry it; then is when the operator will make a bad line on his recording voltmeter chart if he doesn't know just what improper load division will do to the voltage and how to overcome it. How to overcome it when changing from one alternator to another, is what I am endeavoring to explain.

Now when "A" has been running alone and the load has fallen off to such an extent that "B" can carry it, "B" is started and brought up to voltage, parallel with "A" and the load shifted to it as is usually done in plants equipped with voltage regulators and synchonoscopes. But what will happen to the voltage on the two generators if "A" is taken off the line as soon as the load has been shifted to "B" without adjusting the generator field rheostats? The voltage on "A" will probably go as high as the voltmeter will register and the voltage on "B" will probably go very low, which is very undesirable.

Our technical books tell us that we should adjust the general field rheostats until the sum of the alternating

current ammeter readings is a minimum. This is all well and good and will prevent any evil effects, but in a case where a generator is being taken from the line and the graduations on the ammeter near the zero mark are so very small, it is a hard matter to tell just when the sum of the ammeter readings is a minimum.

The method that I use is as follows: Obtain, sometime when the machines are running without any load on them, just how many amperes, at the normal excitation voltage, it requires to excite the fields so that the desired alternating current voltage is obtained—and then put these figures down in the back of the head some place for future reference. Now when you start to take a generator off the line and put another one on, start the new generator, raise voltage on it, parallel it with the one that is carrying the load and shift the load to it in the usual manner, then begin cutting resistance out of the field of the generator that is to carry the load and cutting resistance into the field of the generator that is to be taken off the line. When the excitation current, at normal excitation voltage, on the generator that is to be taken off the line is what you have previously determined that it was when running without any load on it; you are then sure that this generator is not carrying any load, and the switch leading to the bus bars can be opened without having any effect, whatever, on the voltage of either machine. W. M. MILTON.

An Engineer Celebrates July Fourth

THE POWER PLANT of a small street railway in Maine, consisted of a 16 by 32 by 36-in. cross-compound Corliss condensing engine (which we called No. 1) and a 22 by 44 by 48-in. tandem ditto (called the "Big Un") each belted to opposite ends of a line shaft, provided with clutch-couplings, for the purpose of operating all machines with either, or both engines. From clutch pulleys on the shaft were belted two 100- and one 150-kw. railway generators; also, four arc-machines, and two alternators. About 15 mi. of track, with a few rather stiff grades, connected three towns with a small city.

That year, a celebration and fireman's muster were scheduled for the Fourth of July in the city, and anticipating heavy riding on the cars, the machinery was gone over carefully, to locate any defects which might cause interruption to traffic during this great event. Everything seemed o. k. and we looked forward to a good day's business.

The morning of the Fourth dawned auspiciously. No. 1 had been running all night on street and commercial lights. The cars were put on her at 4 a. m. Riding began early, and at 8:30 we changed engines. The fireman and myself wiped up No. 1, and we were then "all set" for a busy day. At 9:15, an ominous knock sounded in the head end of the low pressure cylinder of the Big Un, which grew rapidly worse, and a distinct jar could be felt. No. 1 was started up again, in a hurry, and the Big Un shut down, and an S. O. S. call for help was sent to the car-barn near by. In about a minute, three extra relief men—two motormen and a conductor—swarmed into the engine room on the run, removing their uniform coats and caps as they came. Two men grabbed wrenches and started removing the tap-bolts from the distance-pieces, while the third man rigged up the chain-falls, in order to lower them to the floor.

By this time, the load was above normal. When any of the loaded cars struck a grade, No. 1 would slow down and the voltage would drop 100 or more. Fire flew from the brushes as the bi-polar generators groaned a protest, and slipping belts shrieked a warning that they were being overworked. Having to stand by the circuit-breakers constantly, I had little time to devote to the work on the Big Un, but most down-east Yanks are natural born mechanics, and the boys were doing nobly. By the time the distance-pieces were on the floor, the remainder of the nuts were off the head-bolts, then the head was slipped back on the rod, and the trouble located. The set-screw in the piston rod nut had worked loose, allowing the nut to turn back, and the piston to slam backward and forward on the rod.

To add to our troubles, the water in our tide reservoir was getting low, and hot. The pointer on the vacuum gage was hovering around 20 in. The fresh water emergency injection came to the condenser in a 2-in. pipe, and at 100 lb. pressure. This had to be watched, to avoid flooding the condenser during temporary lulls in the traffic. A big wrench with a 6-ft. length of pipe on the handle put the piston-rod nut back in place, and a new set-screw jammed in tight. A dash of graphite and cylinder oil on the joint, and the head was pushed on and bolted up, the distance pieces replaced. The engine was turning over before the last nut was tightened. Our extra help was laid off, with thanks, as the Big Un was cut in on the line, and No. 1 shut down again. The tide was now coming in, and the vacuum was holding strong at 26 in. At no time had the current been off the feeders for more than 10 sec., and the traveling public never knew that there was a little celebration going on at the plant.

As soon as we got time to draw a long breath, we found, on examining the recording gages, that the Big Un had been off the line 45 min. Some speed, I'll tell the world. M. M. BROWN.

Efficiency of Steam Engines

THIS IS usually reckoned by the ratio between the fuel or the steam consumed and the horsepower generated.

Another way of expressing the efficiency is by the number of thermal units per unit of power in a given unit of time. We charge it with the difference per pound of steam between the total heat in a pound of boiler pressure steam and that in a pound of boiler feed water. Where the feed water is heated by the exhaust, a non-condensing engine may have feed at 212 deg. F. and then there would be for each pound of steam at the engine (according to the gage pressure):

Gage pressure, lb	50	100	200
Absolute pressure, lb	65	115	215
Total heat in steam above 32 deg.	1178.5	1188.8	1199.2

Taking away 65 and 180 heat units respectively for feed water at 100 deg. and 212 deg., we have for the heat given by the boiler per pound of steam:

Feed at 100 deg	1110.5	1120.8	1131.2
Feed at 212 deg	998.5	1008.8	1019.2

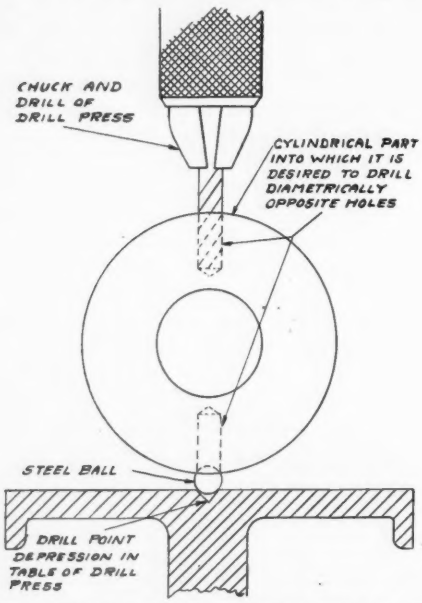
This will give for the thermal units per pound of steam consumption per indicated horsepower per hour:

Feed at 100 deg	18.51	18.68	18.85
Feed at 212 deg	16.64	16.78	16.99

ROBERT GRIMSHAW.

Steel Ball Used in Drilling

IN YOKES, rings, cylinders and other parts where two holes are to be drilled into opposite faces for snug fitting pins or shaft, it is necessary that these be in line with each other. A simple method of accomplishing this result on the drill press is, after prick punch marking the holes, to use a small steel ball, placed into the depression of the drilling table as made by the drill point. Resting the punch mark on the upper point of the ball, the drilling is started and the part reversed to bring the deeper


CHUCK AND DRILL OF DRILL PRESS
CYLINDRICAL PART INTO WHICH IT IS DESIRED TO DRILL DIAMETRICALLY OPPOSITE HOLES
STEEL BALL
DRILL POINT DEPRESSION IN TABLE OF DRILL PRESS

USE OF STEEL BALL IN DRILLING RADIAL HOLE IN CYLINDER

depression over this point. The ball centers the part accurately, and when both holes are drilled these are in exact alinement G. A. LUERS.

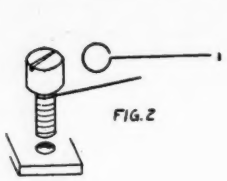
Time Savers

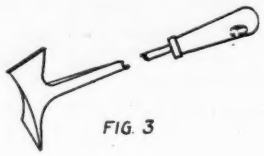
ONE OF the disagreeable jobs that come up in the work of a repair man is that of carrying tools. In my own experience, I know that this starting a day's work by lugging a heavy kit of tools to the job is detrimental to the day's work, as you are tired before you start working.

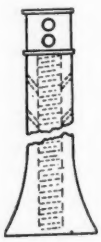
The other day I met an old fellow on the street with a device similar to that shown in Fig. 1. The handiness of the device impressed me at once.

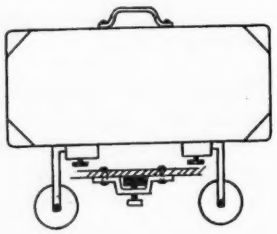
On the bottom of the case clips are riveted; see detail, Fig. 1. The wheel arms were made to slip into these clips, and a thumb screw held them in place. When riding long distances, the wheels can be taken off and slipped into the case in a minute. I think the idea a good one.

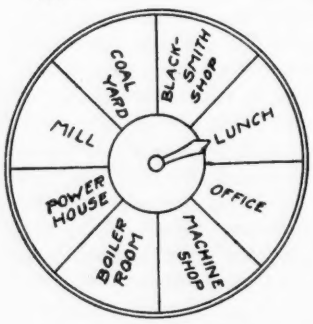
A matter that bothered me a lot was that of putting small screws back in their holes in my work on instruments. Some of the screws are very small, and getting them in place used to be a job I dreaded. One day I











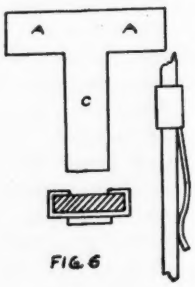


FIG. 1. HANDY TOOL BAG
FIG. 2. WIRE CLIP FOR HOLDING SMALL SCREWS
FIG. 3. OFFSET SCREW DRIVER
FIG. 4. METHOD OF KEEPING A JACK SCREW LUBRICATED
FIG. 5. CHIEF ENGINEER'S DUTCH CLOCK TO INDICATE HIS LOCATION AT ALL TIMES
FIG. 6. POCKET CLIP FOR RULES

happened to be passing a watchmaker's window and I stopped to watch him work. He was putting small screws in a clock and the easy way in which he did it made me actually ashamed of myself, to think I had not thought of that little idea myself. In Fig. 2 is shown the little wire loop with which he held the screw and made easy work of fitting it.

Figure 3 shows an offset screwdriver of an unusual design. In working on the inside of small tanks or in

spaces where two objects come together, so that an ordinary screwdriver cannot be used, this device is just the tool for the job.

Who among us has not started to use a jack screw and found it necessary to take the device apart and clean it because it lacked proper lubrication? Answer—none of us. The following little idea struck me as being mighty good; see Fig. 4. In the illustration, note the diagonal holes drilled in the jack body so that oil can be squirted directly on the screw at any time.

In my day of inspecting, I was often much annoyed by the long periods I had to wait for a certain chief engineer on my visits to his plant. Nobody ever seemed to know where he was and as the man had miles to cover in his supervision, it was some job to find him. I made the suggestion that he have a Dutch clock made. He considered the matter as something of a joke at that time, but agreed to try the scheme, and he tells me now that the device is worth its weight in gold. This is an idea that could well be used to advantage in many plants. Make a clock face with the places where the chief can be reached by phone listed. When he goes to one of these departments, he marks it on the clock, and from that location if he is going somewhere else, he phones back and has the clock give his new location. By this system, he can be located in a few moments, no matter where he is in the plant.

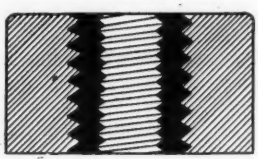
How many of us have wished dire happenings to the 6-in. flat rule we generally carry in our coat pocket, when we reached for it and found it gone? A handy little arrangement that can be made in a few minutes spare time that will prevent this loss is shown in Fig. 6.

Take a flat piece of thin brass and cut out as shown in B, Fig. 6. Bend over the ends marked and curve the end c to grip the coat pocket and lose no more rules.

ARTHUR D. PALMER.

An Emergency Nut

THE WRITER was recently on a job of overhauling a mining plant where the machinery was in pretty bad condition, and where the facilities for handling the repair work were far from satisfactory, as a result of



SECTION THROUGH BABBIT LINED NUT

which he had to fall back on "kinks" in a number of cases.

For instance, in one case we were assembling a big mine pump which someone else had started to take down and had given up as a bad job. Among other parts we found missing about half of the frame bolts, which, upon trying to match them up, we found were with special threads. To get new ones was a matter of weeks, so we decided to distribute the good nuts that we had to best advantage, and then to fill out with some special ones following a scheme recommended by one of the other men on the job. We took some larger nuts with standard threads which we found in the engine house, and set these over the special threaded bolt heads. Holding them in middle position, we then poured in the intervening space a hard babbit mixture. Then after allowing this to set, we pulled up on these combination babbit nuts just sufficiently to get a tight fit, realizing that they would not stand any too much strain. At the same time, these emergency nuts, supplemented by the regular nuts, judiciously placed, insured a sound tight fit of all the parts and eliminated any play or motion which surely would have been set up had we not put on holding nuts of some kind.

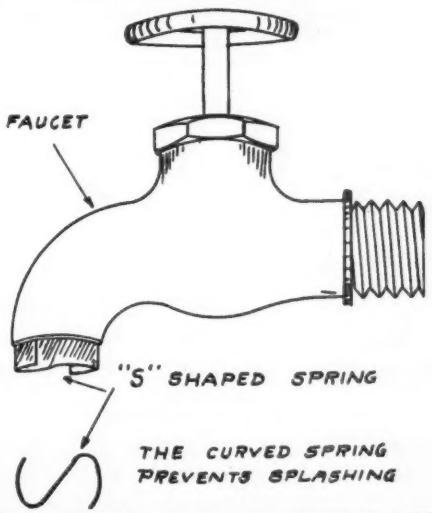
The general appearance of these babbit-filled nuts is shown on the accompanying sketch, and while naturally they are not to be recommended where any heavy load is to be carried, in a situation such as we were up against they answered the purpose in an entirely satisfactory manner.

M. A. SALLER.

To Prevent Faucets From Splashing

SOME faucets will splash very badly and especially so when the water pressure is excessive. A simple and effective means of preventing splashing is described below.

Bend a piece of thin spring brass or phosphor bronze, ¾ in. wide and thin enough to be easily bent into position to the shape shown in the picture.



SPRING INSERTED IN FAUCET PREVENTS SPLASHING

Its diameter should be larger than the mouth of the faucet. Insert it into the mouth of the faucet, and it will be held firmly in place by the spring action.

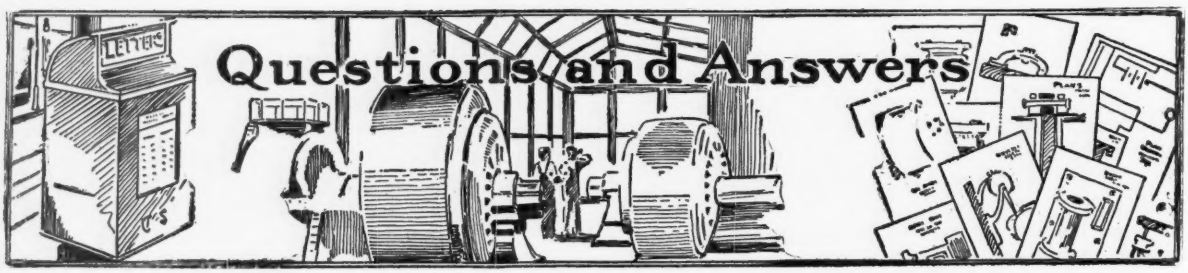
This shape breaks up the whirling rotary effect of the stream and causes it to flow in a smooth, unbroken stream without any splashing.

C. F. RYE.

Mahogany Stain

BOIL LOGWOOD until a strong decoction results. When cold, add ⅓ part of apple cider vinegar. A simple application gives a good mahogany imitation. For a finished job, mix some burnt umber with enough glue to bind or fasten the color on the wood, being careful not to apply too thickly. While still wet, wipe dry with soft cloth and apply above stain. Finish with shellac.

C. C. BROWN.



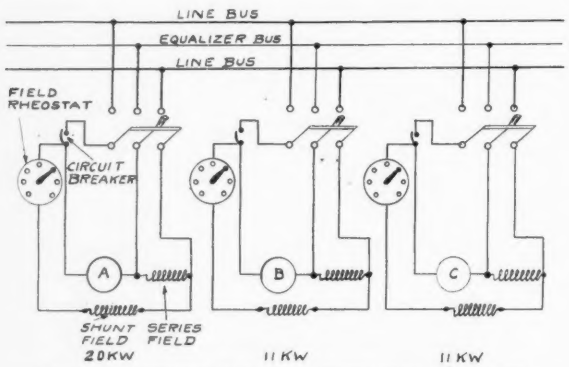
Use of Superheat with Corliss Engines

WE ARE at present installing superheaters on our boilers but I am afraid that our engine will not stand it. I would like to have the opinion of Power Plant Engineering readers as to the results that I may expect.

Will a steam temperature of 500 deg. F. with a pressure of 120 lb. gage affect the valves of a Corliss engine? Will 600-W cylinder oil be suitable for this installation under these conditions? A. C.

Parallel Operation of Generators

IN OUR engine room are three compound wound generators direct connected to steam engines and connected to bus bars as shown in the drawing. The commutators



CONNECTIONS FOR PARALLEL OPERATION OF THREE MACHINES

of machines B and C are quite badly burned. 1. What are the probable reasons for this? 2. If the steam is shut off of unit B and no switches are opened on this panel, what will happen? Will B machine run as a motor? 3. If it does run as a motor would it run in the same direction and would the speed be greater or less than as a generator? A. L. A.

ANSWERS

IT IS probable that the pitting of the commutator of machines B and C is due to the sudden rush of current when these machines are thrown in parallel with A. The conditions would be aggravated by careless operation or by inaccurate voltmeter readings. The voltage of the machine to be paralleled should be identical with the bus voltage. Check your voltmeters against each other with one machine running.

2. If the three machines were operating in parallel and the steam was shut off from B, it would run as a motor unless you have reverse current protection in your circuit breakers. The added load on the other machines might cause their circuit breakers to open.

3. The machine will run in the same direction as a motor. There is no change of polarity so the shunt field excitation is unchanged. The direction of current flow in the series field is changed, hence the motor runs with a weak field. As a result, the machine would speed up although not to a dangerous degree, as the field weakening is limited by the equalizer bus. A part of the current required by the armature of the motor would flow through the equalizer bus, hence would not affect the series field.

To Start Three Turbo-Alternators in Parallel

IN ANSWER to the inquiry in the July 1 issue requesting an opinion as to the best method of starting up an installation of three 625-kv.a. turbo alternators, I would say that although these units are small, the same precautions should be taken while starting as with the larger sizes, because a great many turbine failures have been caused by the improper warming up while coming to speed.

Some engineers employ the same methods in starting turbines as with reciprocating engines, by opening the throttle and blowing steam through while the spindle is stopped.

A practice of this kind should not be followed as the steam, finding the highest part of the turbine casing, causes an unequal expansion of the spindle and blading and when the turbine is then started and while coming to speed excessive vibration and sometimes blade rubbing occurs.

In starting two or more turbo-alternators simultaneously, some engineers prefer bringing each unit up separately and then synchronizing after all are up to speed.

The method I employ, which has many advantages and which I believe will answer the inquiry of T. F., is as follows:

First see that the auxiliary oil pump is supplying oil to the bearing, relay valves, etc., then with the circulating and air pumps running the turbine is ready for steam.

When two or more machines are to run in parallel, the steam exciter should be started first, the main line and field current switches then closed on all machines and the field resistance brought to no-load position. In this way the machines are tied together electrically and will come up to speed in synchronism.

Steam can then be admitted until the spindle revolves at a slow speed for 4 to 10 min., depending on the size of turbines, to insure a uniform warming of the rotating parts. At about half speed, the steam seals or gland water can be turned on and the turbine brought up to speed gradually until they come under the control of the governor.

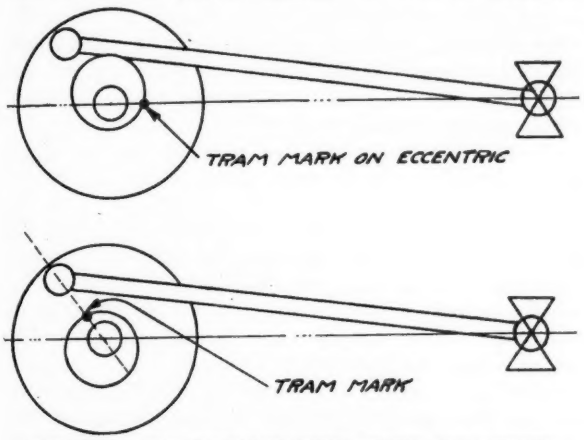
The vacuum should be regulated so that an inlet pressure of not less than 15 to 25 lb. is maintained at all times while running at light load or no load.

By tying the alternators together in the manner described while starting, should it become necessary to shut down the air or circulating pump or any one machine for short repairs, all that is needed is to close the throttle. The generator will then become a motor and will come up to speed with power supplied from the driving units and no harm will be done to the instruments on the switchboard. R. G. SPOONER.

Adjusting Valve Lead

HOW MAY one give the proper amount of lead to the valves of a Corliss engine when the engine is not on dead center and is too heavy to turn over by hand?

A. When the valves have been squared and are ready to set for lead, treat the eccentric just as if the crank were on dead center, regardless of its actual position. Roll the eccentric over in the direction the engine is to run until the proper amount of lead is obtained.



ADJUSTING LEAD OF VALVE WITH ENGINE OFF CENTER

Tram the eccentric on a line through the center of the shaft and the crosshead pin as shown in the first diagram in the accompanying sketch. The eccentric is now in the same position it would have been if the crank were on center and the eccentric 90 deg. plus the angle of advance ahead of the crank. Now move the eccentric ahead until the tram is on a line through the shaft and crankpin. Fasten the eccentric in this position and the valves are set to run. E. G. M.

What Type of Chimney Should Be Used?

WE CONTEMPLATE the erection of a 70-ft. by 4-ft. diameter concrete stack. Before doing so, however, we would like to have an opinion as to the comparative costs, durability, value, etc., of this type of construction as compared with brick or steel stacks.

F. L. & P. Co.

A. The problem of selecting a type of chimney for any given installation is one that requires considerable investigation into the general design of the plant, location, probability of growth, financial resources, fuel used, conditions of combustion, and numerous other points. Each type of chimney has, of course, certain points of advantage for each proposed installation, which if properly detailed would run into quite a lengthy discussion. A brief survey of the advantages and disadvantages of the various types of chimneys in use will, however, be in order.

Brick stacks were the first to be used and are still popular. Their chief advantages are their durability and freedom from high maintenance costs. Settling causes considerable cracking but if taken in time, effective repairs may be made at low cost. On the other hand, the investment represented by such a stack is considerable. Due to the multiplicity of joints, air infiltration is likely to be excessive.

These disadvantages have been somewhat alleviated by the radial brick stack. The initial investment in this type of structure is somewhat less and as there are about one-third the number of joints the infiltration is proportionately reduced.

The full lined self supporting steel chimney is much lighter, more easily erected and costs less than the brick type, and, if properly calked is airtight; but unless a considerable outlay is provided, every year for cleaning and painting, deterioration is likely to be high.

Reinforced concrete chimneys are light, weighing perhaps a third as much as a brick stack of equal capacity, and as to cost are about equal to a steel stack. As it is a monolithic structure, there are of course no joints and the infiltration is negligible. If properly constructed, they are able to withstand considerable tension and compression straining. They can be rapidly constructed and are adaptable to almost any shape. Skill is required in the construction as otherwise cracks are liable to develop which are not easily repaired.

Guyed steel stacks are perhaps most frequently employed in the smaller sizes. They are light in weight and are often mounted directly on top of the boiler and are thus supported by the boiler foundation. They are the least expensive but the upkeep is high.

Imperfections Shown by Indicator Diagrams

REFERRING TO the two indicator diagrams shown on page 776, of the Aug. 1 issue, I should say that the first one, that of D. M. B., shows a lack of lead on both ends. In both cases, the piston has passed the ends of its stroke before admission occurs. If D. M. B. will adjust the valves so that they will be open about 1/16 when the piston is at the end of its stroke, he should then get good results.

I. J. E.'s trouble appears to be in the setting of the exhaust valves. There are three ways of losing compression, namely (1) exhaust valves set incorrectly, (2) steam leaking past the piston, (3) steam leaking past the exhaust valves when they are closed. Each way is characteristically shown on the diagram. Were it either of the latter, there would be some sign of a compression curve, but the square corner goes to show that the exhaust valve was open at the moment of admission. It is quite probable that steam is blowing straight through this engine without doing any work.

My advice to I. J. E. would be to set the exhaust valves so that they will close when the piston is about 4 in. from the end of its stroke. The wavy expansion curve looks suspiciously like leaky admission valves. It might be advisable to take off the cylinder head, close the head end valve and open the throttle a trifle to see if there is any leakage into the cylinder. REG. A. WOODS.

POWER PLANT ENGINEERING

Trade Mark, Reg. U. S. Pat. Office

Issued the 1st and 15th of each month. Established over 26 yr.

Published by the TECHNICAL PUBLISHING CO.

537 South Dearborn Street, Chicago.

New York Office, 150 Nassau St.

Subscription price $2.00 a year in the United States and all its possessions. Canada $2.75 a year. All foreign countries $3.50 a year.

Copies, current issue, 15 cents; back numbers, 25 cents.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1922, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Member, Associated Business Papers.
Member, Audit Bureau of Circulations.

Circulation of this issue, 21,000

CONTENTS

Plant of the Waterway Paper Products Co. Illustrated..... 985
Grates for Moist Fuel. By Zuce Kogan. Illustrated..... 989
Guarantees and Testimonials. By George H. Wallace..... 993
British Practice in Waste Heat Utilization. By C. H. S. Tupholme. Illustrated..... 994
Commercial Value of Exhaust Steam. By Fred William Bosch. Illustrated..... 997
Polyphase Wattmeter Connections—I. By L. P. Staubitz. Illustrated 1003
Selection of Polyphase Motors. By William S. Jones. Illustrated 1005
Pointers on Purchasing Lubricants. By Thomas A. Brown. Illustrated 1006
A Municipally Owned Power and Pumping Plant. By W. C. Looney. Illustrated.....1008
Flywheel Explosions and Their Prevention. By E. B. Tolsted 1010
Distilled Water for Boiler Feed. Illustrated.....1013
Pulverized Mine Waste Gives High Efficiency.....1014
The Sarcastic Engineer. By Robert Grimshaw.....1014
A Balky Air Pump. By John U. Norris. Illustrated.....1015
Punching Belt Holes. By W. F. Schaphorst. Illustrated...1016
Colorado Utility Men Discuss Live Problems at Convention..1016
The Financially Efficient Engine Load. By Robert Grimshaw.1016
Letters Direct from the Plant. Illustrated..... 1017
Successful Kinks from the Power Plant. Illustrated.....1021
Questions and Answers. Illustrated..... 1022
Editorial: The Commercial Value of Exhaust Steam. Navy Day. If I Were a Fireman.....1024
Tilting Manometer Principle Used in New Flow Meter. Illustrated 1026
Cellar Drainer Efficiency Increased. Illustrated.....1027
Ellis Packless Tilting Steam Trap. Illustrated.....1028
New Line Suspension Choke Coil. Illustrated.....1028
A Key That Cuts Its Own Seat. Illustrated.....1029
The "Dot" High Pressure Lubricator. Illustrated.....1029
Portable Loader Utilizes Tank Method of Locomotion. Illustrated 1030
Compressor Is Direct Connected to Oil Engine. Illustrated..1030
Truck Mounted Crane. Illustrated.....1031
Switch Has Quick Break Without Use of Springs. Illustrated 1031
Million-Volt Testing Equipment for University of California.1031
Economy to Be Keynote of Power Exposition.....1032
New Trial Move May Delay Pit River Plant Operation....1032
Fuel Distributor Asks Aid of Industries and Railways.....1032
Cities of Tacoma and Seattle to Exchange Electric Power....1032
Work Begun on 400,000-Kw. Steam Station.....1032
Utilities to Put $30,000,000 Into Ohio Plants.....1033
Commonwealth Edison Co. Authorizes $38,000,000 for Plants..1033
Detroit to Build 150,000-Kv.a. Station.....1033
Compressed Air to Handle Pulverized Fuel.....1034
Henry L. Doherty Now President of Denver Company.....1034
News Notes.....1034
Book Reviews.....1036
Catalog Notes.....1036

The Commercial Value of Exhaust Steam

We are all more or less familiar with figures or diagrams representing production or consumption in a certain industry, in which the particular product under consideration is laid end to end, or side by side, and the line thus formed reaches three, four or seven times around the world as the case may be. Again, with the articles piled up, one on top of the other, the pile would rise some three times as high as the moon. Of course, in these comparisons all such factors as gravity, compressive strength, equilibrium, etc., are conveniently disregarded—these being considered as mere details not sufficiently important to warrant discussion. Whatever the actual value of such far-fetched illustrations or comparisons may be, they are, as a rule, amusing and we generally accept them as harmless gymnastics for the exercise of our imaginations.

Such being the case, we will propound one ourselves. Imagine a train of fully loaded coal cars some 30,000 mi. in length, or, to put it in the customary way, stretching one and one-fifth times around the world at the point of greatest circumference. If this train were unloaded, and the coal formed into a rectangular pile, this pile would be one and one-half miles long, a quarter of a mile wide, and some 800 ft. high. It would contain 160,000,000 T. of coal.

Now, while our imagination is still in a state of extreme flexibility, let us go a step further—let us set fire to this coal pile and watch it burn. But here we protest—even in our imagination we refuse to commit such an economic crime. Think of the waste which would be incurred in carrying out these instructions!

Yet, this is what actually happens. Every year we deliberately burn this enormous quantity of coal without utilizing any of the heat energy in it. To be sure, we don't do it in any one place, but even if the spreading of this wasteful burning of coal throughout the country makes the action less spectacular, is the crime more excusable?

The amount of coal available in the world, although still plentiful at the present time, is limited, and it is our duty to posterity to utilize these fuel resources in the most economical manner possible.

We waste fuel in many ways. The 160,000,000 T. referred to above, we waste by not making use of the available heat energy in the exhaust steam from power generating equipment after the mechanical and electrical energy has been extracted. To illustrate further, we will use an example set forth by Dr. Steinmetz.

Assume that we use 200,000,000 T. of coal per year for power at an average efficiency of 12 per cent, giving 24,000,000 kw., and also use 200,000,000 T. of coal for heating purposes, wasting its potential power.

If, then, we would utilize the waste heat of the coal used for power generation, even if, thereby, the average total efficiency were reduced to ten per cent, we would have left a heating equivalent of 216,000,000 T., or more than required for heating. In other words, the coal consumption would be reduced from 400,000,000 T. to 240,000,000 T., a saving of 160,000,000 T. annually.

While it is obvious that we never could accomplish this completely, even if we recover only one-fourth or even one-tenth of this waste, it would effect a vast increase in our national efficiency.

It is an economic crime to burn coal for mere heating purposes without first taking out as much high grade energy, mechanical and electrical, as is economically feasible. It is equally wasteful to utilize from 8 to 20 per cent of the energy in steam in an engine and then exhaust that steam with its enormous quantity of latent heat to the atmosphere. Yet both of these things are being done in power plants all over the country.

To give the reader a better conception of the commercial value of exhaust steam, Fred William Bosch has prepared a series of articles on this subject, the first of which appears in the pages of this issue. The subject, of course, is one that is more or less familiar to most readers but Mr. Bosch has treated it from a slightly different angle, and has worked out a number of examples which should be of interest to every engineer in charge of a plant.

Navy Day

Friday, Oct. 27, has been designated, Navy Day. On this day let us celebrate the consecration to duty of the personnel of the present Navy and to the glorious service rendered by the Navy of the past.

The Navy has played an important part in the progress of America to its present state and influence. Never aggressive, it has always been ready to safeguard the peace and prosperity of the nation in time of need.

During the World War the Navy rendered vital service to the nation and to humanity as a whole. No great fleet action was fought to give spectacular emphasis to its vital contribution to the victory, but the convoy, the anti-submarine patrol, the mine barrage were essential factors in the winning of the war and the saving of civilization.

So it has been in every crisis of our history—in the War of 1812, the Civil War, the Spanish American War—the Navy has never failed, and victory without the Navy would have been virtually impossible.

The Navy carries no threat, but it lends authority to America's voice, speaking for altruism, justice and law. It is an agent of stability in a troubled world.

In urging the observance of Navy Day let us not be misunderstood; we are advocates of peace, and believe in and support the policy of reduction of armaments by agreement. Until the day comes, however, when the only security needed by mankind shall rest in the hearts and minds of men and nations, let us support the chief instrument of our security—the United States Navy.

If I Were a Fireman

Without question the greatest expense in the generation of power by steam is the fuel which is burned under the boiler. If I were a fireman I would so impress that fact upon my mind that each shovelful of coal, each turn of the stoker wheel or stroke of the plunger would make me see visions of money blowing away. I would know the value of that fuel too, each pound of it. That knowledge would help me to visualize the losses and I would try to keep my mind on the heat that is going to waste rather than that which is actually going into the steam. The possibilities lie in saving the heat that is being wasted.

If I were a fireman I would know just how much air was needed to burn the coal being fed, I'd watch that fuel bed like a hawk to see that no undesirable spots appeared. I'd know the reason for the slightest change in draft and determine just what it should be for the load I was carrying. Feed water and stack temperatures are variables that need close watching, so are the steam pressure, superheat and water level. I'd form a habit of observing these conditions often in some routine order, and as they changed I'd determine the reason and its effects on efficiency. The safety valve would come in for its attention, too; there's no need of running any risks that we know how to avoid.

That is not by any means all the details I would keep in tiptop condition, but they are among the most difficult and have the greatest effect on the results.

That is what I would do for my employer, getting as compensation besides my salary an experience of inestimable value. As a direct benefit to myself, and indirect to my employer, I would acquaint myself so far as possible with the duties of my superior, gain his confidence by faithful and cheerful performance of the work he lays out for me, take as much work and worry off his mind as it is possible for me to do and fit myself to take his place, or one similar, when the opportunity presented itself.

To step out of any position gracefully and carry the friendship of your associates and employers you should have somebody trained to take your place, so I would train a coal passer to do my work; this teaching would not only give me a better knowledge of my work, but would stimulate me to do better work so my pupil would not surpass me.

If I were a fireman I would make myself a specialized scientist solving continuously industrial problems in physics and chemistry. I would make brain work out of it; for every adjustment I made, I would have a definite reason why this should increase the efficiency or accomplish some other required result.

Then, too, if I were a fireman, I would try to be the most likable man in the plant. We are all human; we trust the men we like best and they are the ones who are given the most opportunities and positions of greatest trust, so I would make this quality one of my assets.

With my employer's interest at heart, a master's knowledge of the process of combustion and boiler performance, a scientist's skill in controlling conditions, ability to teach an understudy, a working knowledge of the next higher position and a character that takes well with associates, don't you think an advancement would be in order? I do; and I would go after it, and I'd get it, too, if I had to change locations to get the opportunities I wanted.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.

Develop Water Power Sites.

Promote Health and Safety in Power Plants.

Handle Coal and Ashes Mechanically.

Employ Engineers for Engineering Work.

Tilting Manometer Principle Used in New Flow Meter

REDUCTION of errors from leakage, friction and lag, and the use of a chart having uniform divisions are features of a flow meter which has recently been developed by the H. S. B. W.-Cochrane Corporation, of Philadelphia. Essentially, the working

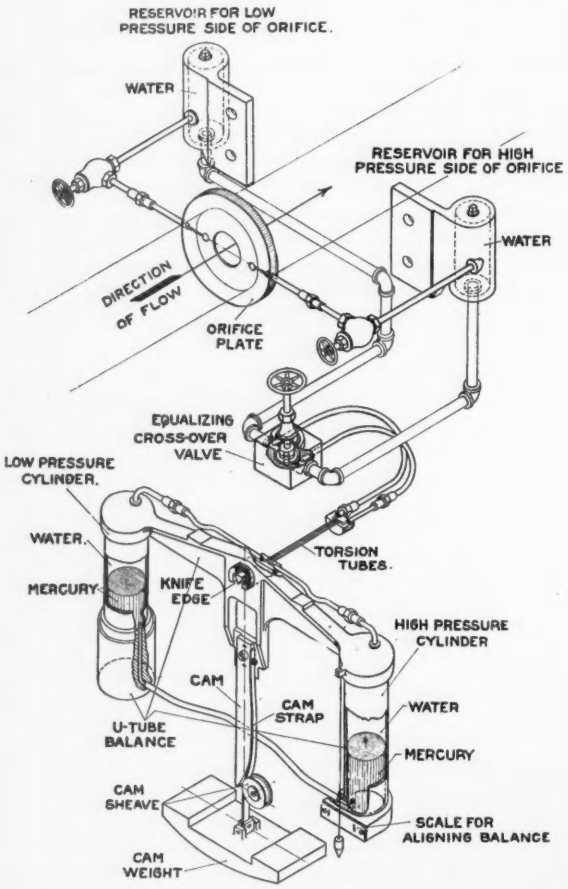


FIG. 1. PRESSURE FROM ORIFICE BROUGHT IN TO TILTING MANOMETER THROUGH TORSION TUBES

parts of the flow meter include the orifice in the pipe line, torsion tubes by which the pressures are led to a tilting manometer (U-tube), and a rectifying cam and weight by which the deflection of the manometer is made proportional to the rate of flow.

While the flow meter can be used with venturi tubes, pitot tubes, nozzles, etc., the standard metering element supplied as a part of the equipment is a sharp-edged orifice in a circular bronze or monel plate, ¼ in. thick, which can be installed inside the bolts between flanges in the pipe line. Its installation does not involve taking down piping, but only unbolting flanges.

The pressure connections to the two sides of the orifice are carried through the orifice plate itself, with openings on the opposite faces of the latter, one facing upstream and the other downstream. By thus including the pressure connections in the orific plate, the user is not required to locate and insert the connections in the pipe line.

It will be noted from Fig. 1 that the pressure pipes from the orifice are led to a tilting manometer instead of the stationary type which has heretofore been used. In the stationary manometer, the recording movement is usually obtained by use of a float operating a spindle, through a stuffing-box. With the tilting manometer, however, the recording movement, for both the indicator and the pen, is obtained by toothed sectors mounted directly on the U-tube beam.

Connecting the orifice pressure pipes with the tilting manometer was a problem which required considerable investigation before a practical solution was obtained. As will be noted in Fig. 1, this is taken care of by means of torsion tubes. These tubes are 6 in. long, made of hard brass, and will stand a pressure of 1500 lb. At one end the tubes are inserted in a stationary block holder while at the other end they are fastened to a holder mounted on the tilting frame. The tubes are so located that the axis of the knife edge of the manometer is exactly midway between the center line of the torsion tubes.

When the U-tube tilts through its small angle of operation, these tubes are twisted. At first thought, it would seem that considerable force would be required to twist these tubes but such is not the case. The small force which is required is compensated for by the cam, which also has functions as shown in the following paragraphs.

As the difference between the pressures on the two sides of an orifice varies as the square of the rate of

FIG. 2. LEGIBILITY IS FEATURE OF THIS RECORD CHART

flow, the movement of the tilting U-tube would not be uniform throughout the range of flow, unless the same method of correction were adopted. It is for this purpose that the cam shown in Fig. 1 has been utilized.

This cam is mounted on the U-tube beam and bears against a flat metallic strap which is kept taut by a weight and guided by a stationary sheave. As the U-tube tilts, an increasing resistance is offered to the

tilting and the cam is so shaped that the tilting is directly proportional to the flow. As a result, a chart with uniform divisions can be used for recording and the divisions of the indicator scale are also uniform throughout its range.

The recording pen has a movement of 4 in. measured radially. There is no back lash, as the pen is so counterbalanced that the sectors are always in mesh on one side of the teeth only. A micrometer adjustment provides for setting the pen to zero. As the pen rests on the chart by gravity, the pressure is uniform, without excessive friction. From Fig. 2 it will be seen that the indicator charts, which are 12 in. in diameter, have been arranged for easy reading at a considerable distance.

In connection with the development of this flow meter, considerable study was given to its possible use under pulsating conditions such as boiler feed pumps.

Reciprocating boiler feed pumps have heretofore been a bar to the use of flow meters, as the pulsating flow causes the meter to read high. It has been sought to overcome this by fitting the pumps with large air chambers, but the air soon dissolves in the water and the air chambers must be refilled frequently. Figure 3 shows a patented arrangement by means of which a flow meter can be used to measure accurately the water drawn by a reciprocating pump from an open heater. A standpipe or reservoir is connected to the pump suction line close to the pump and vented back to the steam space of the heater. The orifice plate is installed in the pump suction line between the standpipe and the heater, while the recorder is placed at some point not higher than about 3 ft. below the water level in the heater. Pet cocks

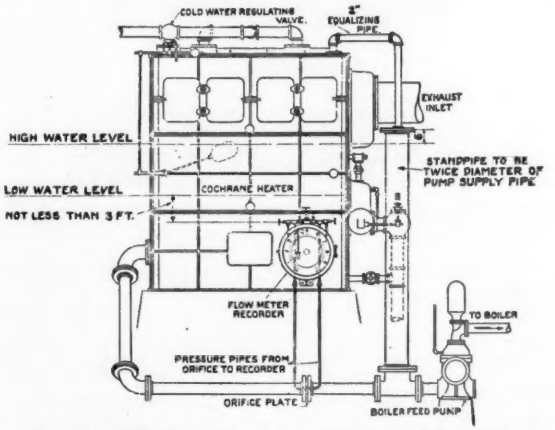


FIG. 3. STANDPIPE USED ON RECIPROCATING PUMP INCREASES ACCURACY OF FLOW METER READINGS

placed at the highest points in the pressure connections permit blowing out air before starting the apparatus.

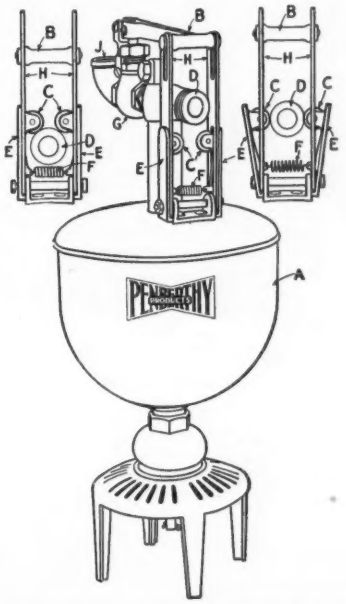
A flow meter in the line to a reciprocating pump supplying a V-notch meter was found to read 21 per cent high: but after connecting the standpipe, the flow meter chart agreed with the corresponding V-notch meter chart within 1.1 per cent. This test was repeated several times with similar results, and there is no uncertainty as to the positive and great benefits obtained by the use of the "play" or standpipe. The action of this arrangement is as follows:

The flow of water to the pump is fluctuating and even intermittent where a single-acting pump is used. Without the play pipe, the flow through the suction line and through the meter orifice fluctuates likewise. With the play pipe connected, the inequalities of flow to the pump are largely made up by the rise and fall of the water level in the play pipe. This can readily be observed from a gage glass attached to the play pipe; but while the level rises, the meter orifice remains very nearly constant, due to the inertia of the flowing water, which acts like a flywheel in keeping up a steady motion, responding only to the average head between the two ends in the line rather than to the instantaneous head.

Cellar Drainer Efficiency Increased

THROUGH the development of a quick acting mechanism for opening the ejector valve, the Penberthy Injector Co., of Detroit, has increased the efficiency of its cellar drainer about 16 per cent.

With drainers of the previous type, some trouble was experienced due to the water rising gradually in the



QUICK ACTING MECHANISM OPENS EJECTOR VALVE TO FULL FLOW IN THIS CELLAR DRAINER

sump and opening the valve just far enough to pump out enough water to prevent the float from rising any higher. As a result, a dead center position was sometimes established with a consequent lowered efficiency of the ejector. The present device, which overcomes this trouble, may be substituted on all drainers of the older type now in use.

The operation of the quick opening valve mechanism is as follows: As the water accumulates in the sump, the float A raises the slotted member H to a point just short of engaging the lever B which operates valve G. Here it is stopped by a pair of rollers C engaging the lower side of web of the ejector casting D with a scissors grip. It is held at this point until the seepage water in the sump has risen around it and built up enough buoyant force to overcome the grip of the rollers and to open the roller arms E against the tension of the

helical spring F. The float A now freed from the restraining rollers C pops upward to its normal flotation level and in so doing, engages the valve lever B which instantly opens valve G to maximum capacity. This starts a full flow through the ejector D and overcomes the dead center trouble mentioned above.

The return action is just the reverse, but the principle is the same. As the water is pumped out of the sump and the water recedes, the float drops the length of the slots in the arms H to a point where the rollers once more engage in the upper side of web of the ejector casting thereby holding the valve G open. As the water recedes still further the weight of the float A overcomes the resistance of the spring tension F; the roller arms E open and the float drops to its normal flotation position, thereby instantly closing the valve G.

Ellis Packless Tilting Steam Trap

NO packing of any description is the distinctive feature of the new "Packless" tilting steam trap manufactured by the Ellis Drier Co., of Chicago. The tank which forms the tilting element of the trap is made of pressed steel with a double head in one end in

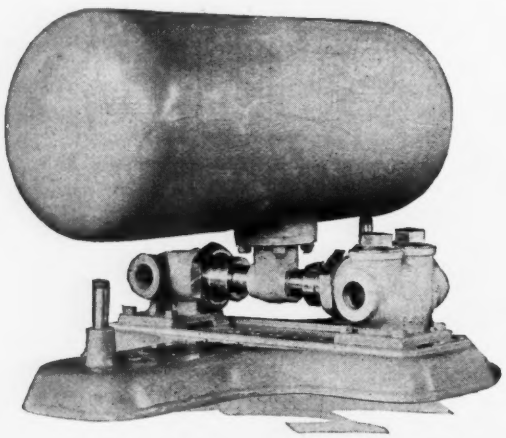


FIG. 1. ELLIS PACKLESS DIRECT RETURN TILTING TRAP

which is placed a stationary counterweight made of the necessary amount of lead to handle the full capacity of the trap at each discharge. The water of condensation runs into the tank of the trap which when empty is in a horizontal position. When sufficient water enters the trap tank to counterbalance the weight in the head, the trap tilts. The tilting of the trap causes the opening of a valve which allows steam to enter the tank, forcing the water out of the trap.

The supporting trunnion of this trap is composed of four parts; namely, the two halves of the joint which are made of monel metal and contain an inserted self-lubricating metal ring, the phosphor bronze diaphragm and the springs which simply maintain a contact between the two halves of the joint when the trap is not in operation.

The outer edge of the diaphragm is held stationary against the body casting by a hexagon nut, which allows the center of the diaphragm to which the monel half of the joint is attached to bend backwards or forwards, depending on the expansion or contraction which takes place in the trunnion. This movement prevents binding of the joint.

In the Ellis steam and vent valve, the outstanding feature is its simplicity and accessibility. Both the steam and vent valves are operated by a two-armed lever which is clamped to the end of the trunnion. The valves are completely enclosed, and each valve is guided at the seat and by a guide in the valve cap, insuring proper

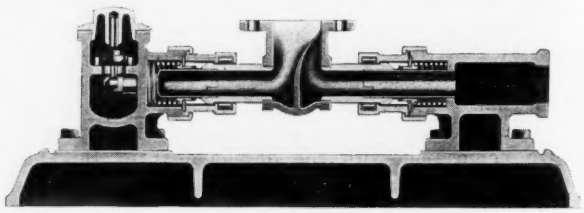


FIG. 2. TRUNNION OF SEPARATING TRAP SHOWING FEATURE WHICH ELIMINATES SOFT PACKING

alinement, as can be seen in Fig. 3. Removing the valve caps gives ready access to the valve discs and seats for inspection or repair. The design of the lift lever is such that one valve seats before the other opens, which prevents any waste of steam and allows the vent to operate with great rapidity.

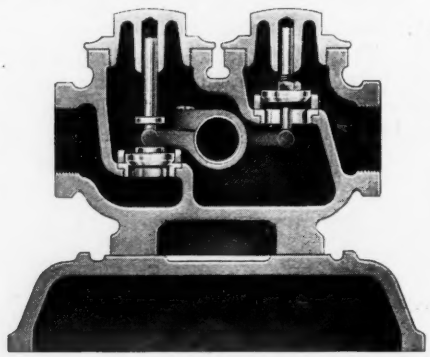


FIG. 3. SECTIONAL VIEW OF DIRECT RETURN TRAP VALVE BODY

These traps are made in sizes to handle from 100 to 4200 gal. of water per hour.

New Line Suspension Choke Coil

TO MEET the demand for a small diameter choke coil to be used on small distribution transformer installations, a new line suspension coil has been developed by the Westinghouse Electric & Manufacturing Co.

TYPE D-6 LINE SUSPENSION CHOKE COIL

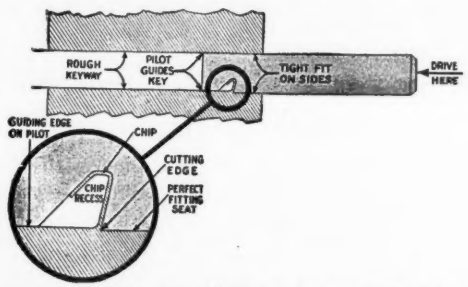
This coil, which is designed for all voltages up to 220,000 normal, alternating current, is intended for installations which do not warrant the expense of higher grade coils. It is to be inserted directly in the transmission line or in the station wiring and held in position by the tension of the wires. The choke coil is made up of 20 turns of copper clad steel wire having a 4 1/6-

in. mean diameter, two clamping strips, and a strain insulator. The strain insulator is arranged within the coil at its axis so that it assumes the mechanical tension transmitted from the conductors. An eye is provided at each end of the coil for supporting it in the line.

A Key That Cuts Its Own Seat

IN A NEW type of key, which has recently been brought out by Smith & Serrell, Newark, N. J., a cutting edge and chip recess are provided near the front end of the key which, it is said, will permit driving the key into the seat without the usual fitting. A tough chisel stock is used, this being ground to a size slightly larger than the nominal keyway width. Ahead of the cutting edge is a pilot which is smaller than the nominal keyway width, hence allows the key to be started into the seat without difficulty.

To install one of these keys, the pilot is placed in the keyway with the cutting edge at one side. Then the key is driven home with an ordinary machinist's hammer or with a sledge, depending on the size of the key.



CUTTING EDGE WITH RECESS FOR CHIPS ALLOWS KEY TO BE DRIVEN IN WITHOUT FITTING

The cutting edge sizes the keyway to make a tight fit between the body and the key and the keyway. In the larger sizes, cutting edges are sometimes provided on both sides. When it is desired to fit top and bottom as well as on the sides, a cutting edge is also provided at the top. Gib keys and other modifications can be furnished.

These keys, which are being produced under the trade name of Keytite Self-Fitting Keys, are said to save the cost of hand fitting and at the same time assure tight fitting keys.

The "Dot" High Pressure Lubricator

THE "DOT" high pressure lubricator recently developed by the Carr Fastener Co., of Boston, and which is shown in the accompanying illustrations, is an exceedingly effective device for forcing oil or grease at high pressure into bearings of practically all types of industrial machinery. As may be noted, it consists of a high pressure grease gun and various forms of self-closing nipples.

The nipples are made in all the various forms necessary to adapt it to any lubricating point on any kind of industrial machinery. They are equipped with ball check valves which precludes all possibility of leakage. Special dust caps snap on and off with no slots in the sides to admit dust. The nipples, of course, are permanently attached to the various points of lubrication.

In using this system of lubrication, the gun, having previously been filled with grease, is placed on the nipple and given a quarter turn to the right. This quarter turn first securely clamps the gun to the nipple and then automatically opens the valve in the nozzle of the gun.

The operator now simply turns the handle of the gun until the old grease, grit and dirt are forced out of the bearing; he knows then, that the channel is clear and that the bearing is filled with new, clean lubricant. The

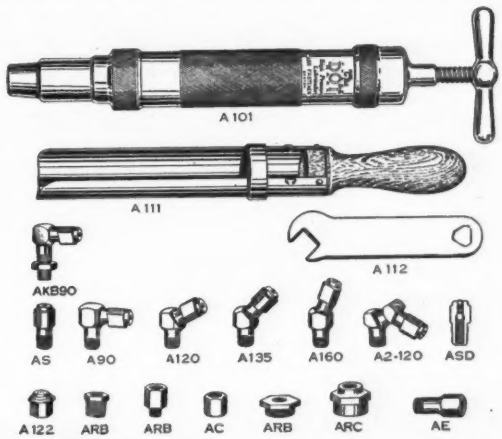


FIG. 1. THE "DOT" HIGH PRESSURE LUBRICATOR SHOWING GUN, FILLER, WRENCH, NIPPLES AND FITTINGS

lubricator develops a pressure of two to three thousand pounds to the square inch.

After the bearing has been lubricated, the gun is detached by a quarter turn to the left, which first closes the valve and then unclamps the nozzle. Because of the automatic feature of this valve, it cannot leak at any time. This feature is of great importance since it permits the use of oil as well as grease and it allows the gun

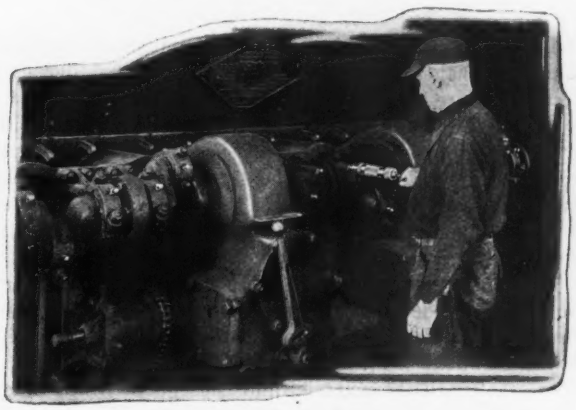


FIG. 2. ILLUSTRATING THE USE OF THE LUBRICATOR ON A STOKER INSTALLATION

to be operated by one hand thereby insuring quicker, easier and cleaner lubrication.

The filler, also shown in the illustration, is a simple, although ingenious, device which enables the gun to be filled solidly, without waste and in the minimum amount of time. Cleanliness is an important feature of the entire system.

The system has been used on, and found well adapted for cranes, hoists, grinding machinery, stokers, coal and other conveying machinery, fans, turbines and numerous other machines.

Figure 2 shows the use of the lubricator on a Riley underfeed stoker installation.

Portable Loader Utilizes Tank Method of Locomotion

A NEW AND improved portable loader recently brought out by The Jeffrey Manufacturing Co., of Columbus, Ohio, makes use of the caterpillar type mounting similar to that used on tanks, but of lighter construction. This loader, which will be marketed under

UNIVERSAL SWIVEL SPOUT PERMITS SPREADING THE LOAD WITH LITTLE MOVEMENT OF LOADER OR TRUCK

the trade name of Tanktred, has a number of features which are said to increase its serviceability under extremely severe operating conditions.

The buckets used on the loader are of heavy malleable iron and are provided with steel cutting edge extending well around the ends of the buckets, which protects the buckets from wear and is itself renewable. The whole bucket is so designed that the digging edge has a cutting clearance at all points.

The foot of the elevator is so constructed that the buckets are wider than any other part, so that the whole machine can be advanced several feet into the pile with nothing but the clean cutting edge of the buckets coming in contact with the material and consequently will handle reasonably hard or frozen material even if it will not flow.

Another distinctive feature of this loader is a relatively large foot wheel, which, by reducing the centrifugal force, enables the buckets to pick up the material and especially the large lumps without kicking them away. A flexible wood boom keeps the buckets digging, but will spring enough to release the buckets from overload strain when they encounter a cave-in or such an obstruction as a railroad tie.

Two speeds, a traveling speed for moving the machine from place to place, and a feeding speed for driving the machine directly into the pile, give a wide flexibility of operation.

A universal swivel spout applied to the loader enables the operator to spot the material in various portions of the truck with very little change of position of either the truck or the loader and saves a great deal of time and manual labor in spreading the load.

A gathering device similar to a road scraper can be attached to the machine, making it possible to gather and load material spread out in a thin layer, or windrow, on road bed.

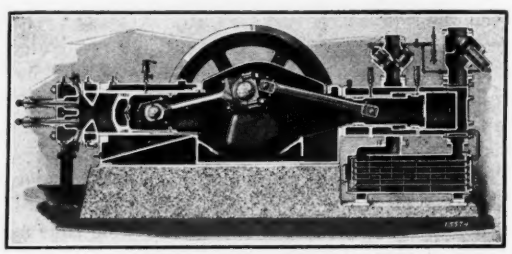
In order to increase the capacity of loading machines by keeping the elevator at work while a full truck is being pulled away and an empty one driven into place, storage hoppers have been developed, so arranged as to catch the discharge from the buckets and provided with a quick opening valve by means of which the contents of the hopper can be promptly discharged into truck. These hoppers are sometimes made with adjustable sides so as correctly to measure material for a batch of concrete mixing machines.

The machine is equipped with either gas or electric power.

Compressor Is Direct Connected to Oil Engine

DIRECT connection to an oil engine is the feature of a compressor which has recently been placed on the market by Ingersoll-Rand Co., of Phillipsburg, Pa. The units are built in 100-hp. and 50-hp. sizes.

In the 100-hp. unit, the air cylinder is in line with the power cylinder but on the opposite side of the crank shaft. For pressures of 100 lb., a two-stage air cylinder



COMPACT ARRANGEMENT AFFORDED BY THIS METHOD OF DIRECT CONNECTION

is used with the intercooler mounted below the air cylinder as shown in the illustration. For pressures below 100 lb. a single stage air cylinder is used. In either single or two-stage compression, the air cylinder is double acting.

For the 50-hp. size, the air cylinder is vertical and is mounted on top of the engine immediately above the crank shaft. By so doing, it has been made possible to mount the unit on a flat car or truck for use in portable work.

This same method of direct connection is also applied to ammonia compressors. These are built in two sizes, one for 63 T. and the other for 31 T. of refrigeration.

These units use the Price oil engines which were described in the July 15 issue of Power Plant Engineering.

Truck Mounted Crane

A LIGHT crane that can be mounted on an ordinary truck chassis and is therefore easily transported has just been placed on the market by the Byers Machine Co., of Ravenna, Ohio. A mounted unit is shown in the accompanying illustration. This outfit called the Byers Truckcrane, can be driven from the

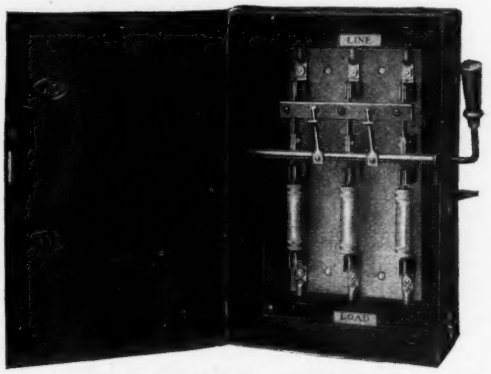
BYERS CRANE WITH TRUCK MOUNTING

garage to the job every morning just like any automobile, or driven from one job to another with a minimum of time lost in travel.

The crane, unmounted, weighs 6 T. It is provided with a Hercules, 4-cylinder, 4 by 5-in. gasoline engine, developing 30 hp. Any half yard bucket weighing not over 2000 lb. can be used.

Switch Has Quick Break Without Use of Springs

THROUGH the use of an operating shaft set eccentric with the axis of the switch blades, it is stated that a quick break without the use of springs is obtained in a switch which has recently been brought out by the Z. & H. Manufacturing Co., of Chicago. As



ECCENTRIC ACTION THROUGH TUMBLERS CAUSES QUICK BREAK OF CONTACTS

shown in the illustration, the operating mechanism consists of a straight rod connected to the external operating handle, while on this rod are two tumblers which engage the cross bar of the switch blades through two metal pieces called differential loops. As the radius of blade swing is different from the radius of the tumbler operation, it is stated that the blades open quickly and without jar.

Other features claimed for this line of switches are that the shaft is fixed and there is no distortion, consequently the contacts remain in perfect alinement; with the blades in the full 90 deg. open position, there is no obstruction of the fuses; elimination of destructive jar through the use of a springless quick break; simplicity, and fewer number of parts.

These switches are listed in sizes up to 400 amp., 250 v. and 500 v. in two, three and four-pole, single and double-throw types. A line of double-throw, motor starting switches, fused on the running side, with the same general features, are also listed.

Million-Volt Testing Equipment for University of California

THE HIGHEST voltage testing transformer equipment that has ever been sold is now being manufactured at East Pittsburgh by the Westinghouse Electric & Manufacturing Co. This equipment is to be installed in the new high voltage testing laboratory of the California Institute of Technology at Pasadena, Calif.

A potential of 1,000,000 v. to ground will be produced by this apparatus. At this voltage, the capacity will be 1000 kv.a. or 1340 hp.

The apparatus will consist of four special 250 kv.a., 250,000-v. transformers connected so that the voltages will be added. The transformer tanks will be insulated from the ground and the insulation will increase with the voltage. This will necessitate mounting of the transformers on wooden platforms at various heights from the ground, the last transformer being on a platform approximately 12 to 15 ft. high.

This equipment will be in charge of Dr. R. A. Millikin, the noted physicist, who is now a member of the faculty of the California Institute of Technology. He will be assisted by Dr. C. E. Darwin, Dr. H. A. Lorentz, Professor R. W. Sorensen, and other members of the faculty and also by several engineers of the Southern California Edison Co.

The 1,000,000-v. testing equipment will greatly facilitate scientific research and, it is understood, investigations will be carried on concerning the properties of matter.

The Westinghouse Electric & Manufacturing Co. has previously built for its own use, a single unit, 1,000,000-v. testing transformer but due to the diversified purposes for which the equipment now being built will be used at California Institute of Technology, it was decided that obtaining 1,000,000 v. by four units would prove to be a more flexible arrangement.

It is planned also to use only three of these transformers on a 3-phase, 435,000-v. transmission line and numerous other combinations can also be obtained.

Arrangements are being made to control the testing transformers individually and also as a 1,000,000-v. transformer from several different control stations located at different points in the new laboratory, so it can readily be seen that the control system alone will require

the use of considerable equipment connected by a maze of wires. A considerable portion of this control equipment will be automatically operated and controlled by push buttons.

It is interesting to note that a potential of 1,000,000 v. between terminals one meter in diameter, will cause a spark to flash across an air gap of approximately 45 in. and, when between needle points, it will jump an air gap of from 12 to 15 ft.

Economy to Be Keynote of Power Exposition

ECONOMICAL use of fuel and the more effectual generation and use of power will be stressed at the National Exposition of Power and Mechanical Engineering which will open on Dec. 7 at the Grand Central Palace in New York City. Equipment exhibited by manufacturers will show modern methods of securing economical production and use of power.

The date of this exposition has been set to follow the annual meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers, in order that members of these organizations may have an opportunity to visit the show.

Engineers well known in the industrial and public utility power generation field make up the exposition advisory committee, which is headed by Irving E. Moulthrop, Edison Electric Illuminating Co., of Boston, as chairman.

New Trial Move May Delay Pit River Plant Operation

THE MOVE for a new trial at Redding, Cal., in the case of the Mt. Shasta Power Corporation against the three Dennis heirs, who were recently awarded $62,500 by a jury in the Superior court, in land condemnation proceedings, will materially delay the operation of the No. 1 plant on the Pit River, pending the hearing of the motion.

While the formal opening of the plant took place on Sept. 30, it is not likely that the company will be able to operate the plant until a settlement of the case has been made.

This plant, which has an installed capacity of 92,000 hp., is now the largest west of the Rockies. Its individual units are hydroelectric generators of 35,000 kv.a. rating.

Fuel Distributor Asks Aid of Industries and Railways

IN order to speed up the movement of coal and to make the available supply go as far as possible, the Federal Fuel Distributor has appointed advisory committees in both the railway and industrial fields. Members of the industrial committee will be asked to assist in the endeavor to have large industrial consumers confine purchases of coal as closely to current needs as safety permits; to suspend accumulation of advance stocks of coal until the present emergency pressure on production is relieved; to unload cars immediately and return them to service and to furnish promptly material required for new railroad equipment or repairs.

Ways and means will be considered by the railway committee to speed up coal traffic. A committee of the National Coal Association is also in touch with Federal officials with a view to arranging a plan of co-operation between the bituminous coal producers of the country and the fuel administration. Naval officers stationed at various points have been appointed field representatives of the Federal Fuel Distributor.

Cities of Tacoma and Seattle to Exchange Electric Power

ARRANGEMENTS HAVE been completed whereby the municipal plants of the cities of Tacoma and Seattle, Wash., will exchange power in case of high demand or emergency conditions on the generating system of either city. The scheme of connections, which was designed by engineers of the Westinghouse Electric & Manufacturing Co., although somewhat elaborate in design, is very simple in operation.

The generating plant of each of the cities transmits power at approximately 50,000 v. The maximum amount of power to be exchanged is 15,000 kv.a., and a 15,000-kv.a., three-phase, water-cooled transformer, having approximately a one to one ratio, will be used to tie the two generating systems together. One side of the transformer will be provided with a number of taps, and a tap changing device will be supplied to vary the ratio of transformation somewhat by means of the taps so that it will be possible, by varying the ratio of transformation, to pass power from either system into the other and also to control the amount of the interchange.

Instead of transferring abruptly from tap to tap, a small induction regulator will be used to give any intermediate voltage between the taps. The induction regulator will be excited from an auxiliary winding on the main transformer and will vary the voltage of a small series transformer having two secondary windings per phase. These windings will be transferred from tap to tap of the main transformer in such a way that it will be possible to obtain any voltage from the maximum to the minimum. The regulator will be operated by a small motor and the various switches will be positively geared to the regulator mechanism so that the entire range in voltage will be controlled by operating two push buttons, one to raise and the other to lower the voltage.

Work Begun on 400,000-Kw. Steam Station

GROUND has been broken on the site where the Brooklyn Edison Co. will erect a steam station which will have an ultimate capacity of 400,000 kw. This plant will contain single cylinder turbines with a rating of 62,500 kv.a., the largest units of this type which have ever been built. The original installation will be made up of two of these units and eight 1695-hp. boilers.

The site is on Hudson Ave. adjoining the Brooklyn Navy Yard and facing the East River. It is expected that the first section of the plant will be placed in operation about November, 1923.

The Westinghouse Electric & Manufacturing Co. and the General Electric Co. will each build one of the turbine units. Babcock & Wilcox water-tube boilers have been ordered and the stokers will be supplied by Westinghouse and the Combustion Engineering Corporation.

It is estimated that the cost of the station will be about $80 a kilowatt. Thomas Murray as consulting engineer and the engineers of the Brooklyn Edison Co. are designing the station.

Utilities to Put $30,000,000 Into Ohio Plants

TWO steam electric power stations are to be located in eastern Ohio, the work to start in the next few months, as part of a program of expansion on the part of the public utilities of the state. The total investment will exceed $30,000,000, it is reported, and will add approximately 550,000 hp. to Ohio's power resources.

The American Gas & Electric Co., through its subsidiary, the Ohio Power Co., is planning to build near Zanesville a duplicate of its Newark central station. It will be tied in with both the Newark and the Windsor or Beech Bottom, W. Va., plants and furnish current for transmission system running as far north as Fremont on the west and Akron on the east.

The Ohio Power Co.'s Zanesville plant, with final installations, is to cost between $15,000,000 and $20,000,000 including transmission lines. Eventually it will have a 200,000 kw. capacity.

The Pennsylvania-Ohio Power & Light Co. of Youngstown is planning to build a large station along the Ohio River near Steubenville to supply power to the Youngstown industrial district, running as far north as Warren. Plans for the plant and transmission lines are reported to call for an investment of $15,000,000.

Commonwealth Edison Co. Authorizes $38,000,000 for Plants

AT A RECENT meeting of the directors of the Commonwealth Edison Co., Chicago, expenditure of $38,000,000 was authorized to be used for the enlargement of the new Calumet Station and the building of a new plant on the West Side, at Crawford Ave., near 39th St.

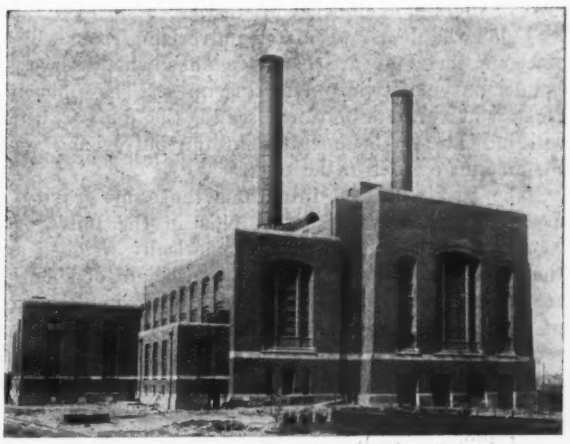
The enlargement of the Calumet Station calls for the completion of the third section of this plant which means that two more units of 30,000 kw. capacity will be installed, bringing the total station capacity up to 180,000 kw. According to the original plans, this rating was to be the ultimate capacity of the plant; but it is possible that this will be still further expanded with the growth of the system.

It is on the West Side that the most important development is to take place, as the plant on Crawford Ave. will eventually be the largest plant on the lines of this company and it will in all probability be the largest plant in the world. Plans which are yet in the tentative stage call for the installation of two units of approximately 50,000 kw. as the first section of the plant. The ultimate capacity is somewhat in doubt as the site of 67 acres and the design of the building will permit of greater expansion than is possible at any other plant on the system. It is probable that the station as laid out will have a rating of 300,000 to 500,000 kw. in the not far distant future.

In general, the design of the new station will be along the lines of the Calumet Station, although the size of the individual units will be increased over those used in that station. The steam turbines will be of the single cylinder type, and the generators will be wound for 12,600-v., three-phase, 60-cycle current.

Condensing water will be taken from the drainage canal, as the plant will be located on the North side of this stream. Information on the detailed features of handling the cooling water, size of boiler units and number of units per turbine is not yet available. It is thought that the practice in the boiler room will follow the Calumet Station and in that case boilers of about 1500 hp. would be used.

One feature of interest will be in the increased coal storage facilities. On account of the space available, it is expected that this plant will have a greater storage



CALUMET STATION WILL BE INCREASED TO 180,000 KW.

in proportion to its size than any other plant on the system. According to officials of the company this point has been carefully considered because of the uncertainty of the fuel situation during the past few years.

The building will be faced with pressed brick, while the interior will be finished off in white enameled brick and tile. More than usual attention is being given the architectural features and it is expected that the finished building will be the most attractive power plant building yet built by the company.

According to plans work on the new plant will begin in the spring of 1923, while it is expected that the third section of the Calumet plant will be in operation by the fall of 1923.

Detroit to Build 150,000-Kv.a. Plant

THE Public Lighting Commission of the City of Detroit is planning to construct a power plant to have an ultimate capacity of 150,000 kv.a., of which four units of 25,000 kv.a. each will be installed at the present time.

The site, comprising 17 acres, is in the southwestern part of the city. It has river frontage and will be served by both the Wabash and the Michigan Central railroads.

This plant will provide for all municipal requirements such as lighting public buildings and streets, water works and sewage pumping stations and the street railway system.

In connection with the plant, a complete transmission system will be installed, including substations for the street railway system.

Bids will be taken on boilers, stokers, economizers, turbines and condensers as soon as specifications can be prepared. Smith, Hinchman & Grills are the engineers.

Compressed Air to Handle Pulverized Fuel

AMONG the further details regarding the equipment to be used in handling the pulverized coal at the New Cahokia Station of the Union Electric Light and Fuel Co., St. Louis, Mo., the method of weighing the fuel, and conveying it from the pulverizers to the boilers is of unusual interest.

Below the floor level of the pulverizing room will be placed a series of five blowing tanks which serve an equal number of twin pulverizing units. These blowing tanks will rest on platform scales, the dial of which will indicate to the operator in the pulverizing room the amount of fuel in the tank.

The fuel will feed into these tanks by gravity as desired from pulverized fuel bins in the pulverizing room. Each charge will be automatically weighed and then elevated by compressed air to a height of about 75 ft. through 4-in. pipes. By means of a simple system of switching valves and parallel distributing mains, cross connected, any blowing unit can discharge into any of the eight enclosed storage hoppers in the boiler house. These hoppers serve the four pairs of boilers of 1780-hp. each, comprising the first group of boiler units to be installed.

The fuel requirements for the first group of units is estimated at 1000 T. in 16 hr.

Henry L. Doherty Now President of Denver Company

BACK to his old love is Henry L. Doherty, who again takes up the reins as president of the Denver Gas & Electric Light Co., the position made vacant by the recent death of Frank W. Frueauff. It was about 22 yr. ago that a man in his thirtieth year came to Denver to take charge of the Denver Gas & Electric Light Co., a plant that was pronounced due for an early demise,—a colossal failure. This young man, Henry L. Doherty, had visions of the future and 46 mo. later he was called to New York to assume more important duties. What was thought to be a failure he had changed into a power plant that was selling for display signs and general illumination more current per capita than was used in the city of London, England, for all kinds of electrical current, including power. In assuming the duties of president of the Denver plant, Mr. Doherty will continue to abide at his New York address.

Mr. Doherty plans to heat 100 representative Denver homes, this winter, with gas and if the venture is a success he will extend the new rate to all gas users, a rate that will equal or better the cost of coal. The outcome will be watched with interest, as Mr. Doherty is known for his stick-to-it proclivities.

News Notes

THE ELECTRIC POWER CLUB has moved its headquarters from St. Louis to Cleveland. The step was deemed advisable because of the convenience of the more central location, more than one-third of the membership being located in Ohio. This association is made up of 85 manufacturers of electric power apparatus and control equipment and is organized for the purpose of promoting standardization, improving production methods and increasing distribution of electrical apparatus. The officers are: R. J. Russell, president; C. H. Roth, vice-president; J. K. Bass, treasurer; and S. N. Clarkson, executive secretary.

WHAT is reported to be the first application of pulverized coal to the soda ash industry is being made at the plant of the Diamond Alkali Co., Painesville, Ohio. This company has recently authorized the Fuller Engineering Co., Allentown, Pa., to design and equip the first unit of a coal pulverizing plant to supply the soda ash driers and the boilers with pulverized coal, the ultimate capacity of the plant being 1600 T. of coal per day.

To take care of the first unit, there will be installed 6 ft. 6 in. by 50 ft. Fuller indirect fired coal driers, 46-in. screen type, gear driven mills, a distributing system for conveying the pulverized coal from the mills to the various furnace bins supplying the driers and boilers, 3-in. pulverized coal feeders for feeding coal from the service bin to the burners, and horizontal type burners.

The pulverized coal, after being dried and pulverized, will be conveyed through a 5-in. pipe line, a distance of about 750 ft. to the furnaces. The furnace bins will be equipped with automatic bin indicators which will notify the operator when the bin is full or empty. All coal will be weighed on an automatic scale before being transmitted to the furnace, thus enabling them to keep accurate check on the fuel requirements in each furnace.

THE GREAT ELECTRIC power project of the Victorian Government in Australia is going forward rapidly and in two years it is planned to have a 50,000-kw. plant in operation at Marwell. This station, which is to be situated at the new township of Yallourn, about 5 mi. from Marwell, will contain, initially, five 12,500-kw. turbo-generators. All the principal contracts for the plant and machinery for the main power station are now being placed; a considerable portion of the transformers, switchgear, etc., already having been delivered.

The greater part of the preparatory work of the site has been completed and gangs have been organized for the erection of transmission line over a distance of 112 mi.

On the coal mining operations, the removal of overburden has already commenced and it is expected that the digging of coal will be commenced by the end of this year.

Specifications, contract conditions and tender forms are being received in the United States for the information of American firms desiring to bid on contracts for material going into the Morwell project. Such forms covering strain and pin type insulators, one 1500-kw. back pressure, turbo-generator, with accessories, water-tube

boilers with accessory plant, and steelwork for building an electrically operated coal handling plant are now available to American companies interested who may obtain copies from the New York and Chicago district offices of the Bureau of Foreign and Domestic Commerce or from the Commissioner for Australia in the United States, 61 Broadway, New York.

THE UNITED STATES COAL & COKE CO., Gary, W. Va., is planning to use bone coal, which was formerly considered waste, as a boiler fuel. To this end the company is installing in its new power plant two 46-in. Fuller-Lehigh screen mills for pulverizing coal. A distributing system for conveying the pulverized coal from the mills to the furnace bins and each 800-hp. boiler will be equipped with five vertical burners, taking the fuel from five 3-in. screw feeders.

THE ANNUAL sales convention of the Kerr Turbine Co. was held at the plant, Wellsville, N. Y., on Sept. 11, 12 and 13. Interesting business sessions were interspersed with many enjoyable trips through the adjoining country, and also by entertainment at the Sagamore Camp of Paul B. Hanks, president. General renewed activity in business was reported from all sections, from the Atlantic to the Pacific Coast and from Texas to Canada. An inspection of the plant was also made, particular interest being shown in the very complete test department.

THE JOHNS-PRATT CO., of Hartford, Conn., has appointed George V. W. Ingham as Eastern sales manager for the electrical division. He will make his headquarters at the New York office of the company in the Liggett Building. Mr. Ingham until recently held the position of Eastern sales manager of The Bryant Electric Co., with whom he was associated for 11 yr. Prior to that, he was associated with Pass & Seymour, Incorporated, as Western sales agent.

AMES & CAMPBELL, Boston, Mass., has recently organized to take over the sales representation in New England of several organizations in the power plant equipment field. Among those already represented are Climax Smoke Preventer Co., of Boston; Automatic Fuel Saving Co., of Philadelphia; and Charles V. Hoffman Co., Inc., New York, refractory cements.

C. W. HORN, manager of the Radio Division Service Department, Westinghouse Electric & Manufacturing Co., has been appointed as superintendent of radio operations of the Westinghouse Co. Mr. Horn succeeds L. R. Krumm, who left the service of the Westinghouse Co. to become manager of the Radio Department of the Erner-Hopkins Electric Co., of Columbus, Ohio.

THE POWER SPECIALTY CO., 111 Broadway, New York, announces the appointment of Pell W. Foster, Jr., as New England District Manager, with offices at 50 Congress St., Boston. Mr. Foster was formerly in the New York sales office.

W. S. RUGG, assistant to the vice-president, has been appointed general manager of sales of the Westinghouse Electric & Manufacturing Co. The appointment, which was announced by Vice-President H. D. Shute, takes effect immediately.

ARTHUR W. BINNS, formerly assistant engineer of No. 18 Boiler House of the Power Department of the Atlantic Refining Co., has resigned to become chief engineer and building superintendent of the Pennsylvania Hospital, Philadelphia, Pa.

THE POWER HOUSE of the Peavy-Moore Lumber Co. and its sawmill at Beaumont, Texas, were destroyed by fire early Sept. 23. The loss is estimated at $200,000.

M. F. KING, formerly of the King Refractories Co., has joined the sales and service department of the Quigley Furnace Specialties Co. Mr. King will devote his attention to service and sales work in New York City.

THE MARK SHIELDS COAL CO., of Gillette, Wyoming, has opened up a vein of coal 95 ft. deep and covering 800 acres. The coal is uniform in character and the vein is one of the largest in the United States.

EXPERIMENTS which have been conducted by the United States Radio Corp. of San Francisco have shown that it is possible to transmit sufficient energy with an ordinary high power radio set to light two 120-v., 50-w. tungsten bulbs at a distance of 2000 ft. A special "hook-up" was used on the receiving set.

THE POTOMAC ELECTRIC CO. of Washington now has 21 sub-stations throughout the city and vicinity. The main generating station has 90,000 kw. capacity. There are eight sub-stations for supplying direct current to the Edison system, 3-wire d.c. light and power service downtown; railway current to their subsidiary, the Washington Railway & Electric Co. and some of the outlying districts. It is rumored that some three and a quarter million dollars in new power equipment and supplies are to be purchased in the next 12 or 18 mo.

SEPTEMBER COPPER sales are estimated at about 125,000,000 lb., an increase of 25,000,000 lb. over August. In July sales also totaled 125,000,000 lb. Of the total sales for September it is estimated that slightly less than 25,000,000 lb. were sold by the Copper Export Association which is now believed to have not more than 160,000,000 lb. of unsold metal on hand. With September included, estimated total sales of copper for the nine months amounted to 1,180,000,000 lb., or at the rate of 1,572,000,000 lb. for the full year.

U. S. CIVIL SERVICE COMMISSION announces an examination for mechanical engineer, receipt of applications to close Nov. 7, to fill a vacancy in the Coast and Geodetic Survey, Washington, D. C., at $3000 a year, and vacancies in positions requiring similar qualifications, at this or higher or lower salaries. Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience, and fitness. Applicants must show that they have been graduated in engineering, preferably mechanical engineering, from a college or university of recognized standing, and that, in addition, they have had at least 3 yr. experience as designer of precision instruments, preferably instruments used in surveying; those who have successfully completed at least 2 yr. of such engineering course may substitute, for each year lacking completion of such course, an additional year of experience of such a nature as to qualify the applicant to design precision instruments. Scientific courses other than engineering will be accepted for not more than ¾ time value. Applicants must have reached their twenty-fifth but not their

forty-fifth birthday on the date of the examination. These age limits do not apply to persons entitled to preference because of military or naval service, but such applicants must not have reached the retirement age. Apply for Form 1312, stating examination title.

Book Reviews

FUEL AND LUBRICATING OILS FOR DIESEL ENGINES by W. Scheulser; size, 5½ by 8½ in.; 114 pages, 26 illustrations, cloth; New York, 1922.

In the last few years the number of fuel oils suitable for Diesel engines has increased to such an extent that there is some confusion regarding the proper specifications and use of these liquid fuels. The author in connection with his work as chief engineer of the Diesel engine department of Sulzer Freres, Societe Anonyme, Winterthur, Switzerland, has compiled data which should be found useful to operators of Diesel units.

Although petroleum oils constitute the principal fuel for Diesel engines, there is an increasing use of coal tar oils. Fuels such as lignite tars and shale oils, oil gas tars, and vegetable oils are also being used to a greater extent. In the use of all of these fuels, the specifications covering specific gravity, flash point, viscosity, calorific value, ash content, sulphur content and water content are of importance to satisfactory operation, the author has covered quite completely the minimum and maximum specification ranges for these various fuels.

Lubricating oils are so nearly related to the fuel oils that a discussion of these has also been included as well as directions for carrying out tests on both fuel and lubricating oils.

HEATING AND VENTILATION, by Allen and Walker; 332 pages, size 5¾ by 9, cloth, New York, 1922.

This, the second edition of Heating and Ventilation, has been largely rewritten, revised and somewhat enlarged because of the advances in the art which have been made since the first edition was published in 1918, such as the formulation of ventilation standards and the work of the Research Laboratory of the American Society of Heating and Ventilating Engineers. Much of the new material is taken directly from Prof. Allen's findings while director of this Laboratory.

The book contains 18 chapters treating heat losses from buildings; methods of heating, such as hot air, steam, hot water, etc., in all their various ramifications; radiators; boilers; fittings; piping; temperature control; ventilation and air conditioning; fan systems; and lastly, central heating systems.

Although the calculus has been resorted to in certain parts for the sake of completeness, such parts may be omitted without destroying the continuity; otherwise the text is perfectly comprehensible to anyone having a working knowledge of simple arithmetic.

MACHINISTS' AND DRAFTSMEN'S HAND BOOK, by P. Lobben; 487 pages, size 4½ by 7½ in., flexible, New York, 1922.

While this handbook is primarily a reference book, in some cases it goes into the fundamental principles upon which certain rules of thumb, empirical equations and formulas are based. In this sense, it becomes an elementary text on the subjects covered.

The use of abstruse theories and complicated formulas is avoided. Every subject is handled from a practical point of view. Formulas given are such as will enable intelligent approximations to be made. Scientific hair-splitting is sacrificed to this end.

Subjects covered are arithmetic, algebra, logarithms, strength of materials, mechanics, bearings, gears, screws, pipes, notes on hydraulics, steam, electrical terms, shop notes and blueprinting.

Catalog Notes

DAVIDSON pumps for all services in steam plants are illustrated and described in the new 40-page catalog of M. T. Davidson Co., 45-53 Keap St., Brooklyn, N. Y.

A FOLDER from Midwest Steel & Supply Co., 28 W. 44th St., New York, illustrates the use of the Midwest System which is based on the use of Midwest steel sections.

LINE SHAFTING EQUIPMENT is covered in catalog No. 43, recently issued by the Medart Co., of St. Louis. Much information of a handbook nature, applying to line shafting, is given in the 192 pages, which are well illustrated with the equipment manufactured by this company.

THE BOILER equipment at the River Rouge plant of the Ford Motor Co. is described in bulletin No. 21, recently issued by the George T. Ladd Co., of Pittsburgh, Pa. This plant, which contains boiler units of 2647 hp. normal rating, has some features of unusual interest which are covered in an interesting manner in this bulletin.

TECHNICAL BULLETINS have been issued by A. W. Cadman Manufacturing Co., Pittsburgh, as follows: Engineering Bulletin M-1, Cadman Metals, a digest of 60 yr. pioneer work in the development of fine bearing metals; Engineering Bulletin M-2, types of bearing metal, requirements of a bearing metal, alloys and the theory of bearing metals, friction in bearings, and permissible bearing pressures.

THE JEFFREY MANUFACTURING CO., Columbus, Ohio, is sending out its new catalog, No. 368, on Jeffrey Swing Hammer Pulverizers adapted for reducing all kinds of friable materials. This catalog has 42 pages of concise, accurate description, data and other information, together with numerous shop illustrations and installation views showing the wide application of Jeffrey Swing Hammer Pulverizers, which are built in the following types: Type A for general purposes, Type B for breakdown machines and fine grinding, Type D for fine grinding of limestone and similar rock.

THE ENGINEERING DEPARTMENT of the Holophane Glass Co., 342 Madison Ave., New York, has just issued a 36-page illustrated booklet entitled "Modern School Lighting," which not only gives general information regarding school lighting, but contains complete tables of utilization constants for all conditions of room size and decorations. A simple form of reflectometer is included so that the reflection factor of paints ordinarily used for ceiling and walls in school buildings can be easily determined. Cross reference tables also show the types of lighting units suitable for all school locations such as auditoriums, classrooms, drafting rooms, gymnasiums, etc.